DOCUMENT RESUME

ED 220 718 CE 033 829

TITLE	Engineering Technology Programs. Preliminary Curriculum Planning Guide.
INSTITUTION	Center for Occupational Research and Development, Inc., Waco, Tex.
SPONS AGENCY	Georgia State Dept. of Education, Atlanta. Office of Vocational Education.
PUB DATE	Aug 82
NOTE	120p.
EDRS PRICE	MF01/PC05 Plus Postage.
DESCRIPTORS	Competency Based Education; Course Descriptions; Curriculum Design; *Curriculum Development; Educational Objectives; Electrical Occupations; *Electromechanical Technology; *Electronics; Engineering Education; Engineering Technicians; *Engineering Technology; Guidelines; *Mechanical Design Technicians; Program Development; Secondary Education; Technical Education
IDENTIFIERS	Georgia

ABSTRACT

Developed as a resource to assist in a major revision underway in Georgia area technical schools to change curricula for preparing engineering technicians, this preliminary program-planning guide describes curriculum structures for specialized programs in three major areas--electronics, electromechanics, and mechanics. The handbook, which is intended for use by six pilot schools that will begin testing the new high-technology programs in the fall of 1982, describes course outlines and student competencies for all courses in the first year of the curricula. Covered in the four sections of the guide are the following topics: training the technician (rationale, purpose and objectives, technicians defined, faculty and staff, and accreditation); curriculum organization (course groupings, minimum credit requirements, curriculum development, and materials development); curriculum design; and curriculum content. (MN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED220718

ENGINEERING TECHNOLOGY PROGRAMS

PRELIMINARY CURRICULUM PLANNING GUIDE

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

This document has been reproduced as received from the person or organization originating it.
Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

DEVELOPED UNDER AGREEMENT WITH

DIVISION OF PROGRAM DEVELOPMENT
OFFICE OF VOCATIONAL EDUCATION
GEORGIA DEPARTMENT OF EDUCATION
ATLANTA, GEORGIA 30334

CHARLES McDANIEL, STATE SUPERINTENDENT OF SCHOOLS

AUGUST 1982

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

A Maughon

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

CE-033829

Prepared by
THE CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT
601 C Lake Air Drive
Waco, Texas 76710

PREFACE

The term "high technology" has been used in recent years to describe and refer to the most advanced devices, processes, and machinery in the modern world. High technology holds the promise to our state's future growth and productivity; it also demands new skills and a broader knowledge base for our future technical workforce.

Georgia is responding to this workforce demand by encouraging its area technical schools to undertake revolutionary changes in curricula to prepare engineering technicians. Six pilot schools will begin high-technology programs in the fall of 1982.

This preliminary Program Planning Guide describes curriculum structures for specialized programs in three major areas: electronics, electromechanical, and mechanical. Course outlines and student competencies are described for all courses in the first year of the curricula.

The document is intended as a guideline for use by the pilot schools; it will be revised next summer, based on the experience gained by faculty and administrators of the pilot schools. Early in 1983, similar guidelines will be issued for second-year courses in the specialty curricula areas.

William P. Johnson
Associate State Superintendent of Schools

ACKNOWLEDGMENTS

The three lead schools that will begin this fall with full course offerings in high-technology programs and will provide leadership in the development of one specialty area are:

Augusta Tech - Electromechanical
Columbus Tech - Mechanical
DeKalb Tech - Electronics

Three additional schools that will also begin offering courses in high-technology curricula areas are:

Athens Tech
Marietta-Cobb Tech
Savannah Tech

Overall responsibility and planning for this effort have been under the direction of Dr. John Lloyd, Director, Division of Program Improvement, and Mr. Robert K. Mabry, Coordinator, Research Coordinating Unit.

Coordination of the curriculum development was provided by Dr. Kenneth Allen, Georgia State University Vocational and Career Development Department, Dr. Harmon R. Fowler, Chairman.

Technical expertise in curriculum design and the preparation of this document were provided by Mr. Daniel M. Hull and Dr. Maurice W. Roney, Center for Occupational Research and Development, Waco, Texas.

CONTENTS

	Page
Preface	iii
Acknowledgments	iv
Section I. Training the Technician: An Overview	1
Rationale	3
Purpose and Objectives	3
Technicians Defined	4
Faculty and Staff	7
Accreditation	8
Section II. Curriculum Organization	9
Course Groupings	11
Minimum Credit Requirements	13
Curriculum Development	14
Materials Development	16
Section III. Curriculum Design	21
Section IV. Curriculum Content	35

SECTION I
TRAINING THE TECHNICIAN: AN OVERVIEW

TRAINING THE TECHNICIAN: AN OVERVIEW

RATIONALE

Releveant education and training to prepare engineering technicians is a critical concern for the productivity needs of this nation. As new and changing technologies and processes for manufacturing, construction, communication, energy, and research and development occur with great rapidity, the need for engineering assistants who can perform the "nuts-and-bolts" problem-solving tasks associated with current technology has increased significantly. Modern industrial and engineering devices that are multisystem in nature require the sort of developmental, maintenance, support, and operational personnel who can change, adjust, and adapt to new situations and utilize increasingly sophisticated hardware with a minimum of retraining. In all, this trend toward innovation as the status-quo has heightened the need for a trained technician who combines theoretical and conceptual knowledge with the manipulative, "hands-on" skill of an artisan or craftsman. It is toward this end that modern technical education must be focused. The remainder of this document offers a description of procedures necessary to train engineering technicians who can make a contribution in the emerging technologies.

PURPOSE AND OBJECTIVES

The purpose and objectives of this technician training are as follows.

Purpose

The purpose of the Engineering Technology Program in Georgia is to produce specialists who possess the broad base of knowledge, skill, and attitude necessary to be productive in modern technical occupations that are characterized by rapid change and high sophisticated content.

Objectives

1. To provide basic knowledge, skills, and attitude development grounded in a continuing analysis of the occupational domain to be served.

2. To produce a technician who is able to deal with the complex systems interactions that characterize modern technological environments.
3. To provide program options that allow in-depth study in specialized areas of the occupational domain beyond the basic skill level.
4. To provide for awarding of credit leading to an associate degree credential, as well as options toward other degree credentials.
5. To provide instruction that maximizes the application of knowledge, skills, and attitudes to real work situations.
6. To provide instruction that prepares the student for the complex problem-solving nature of highly technical occupations.
7. To fully coordinate the high-technology program with needs of business and industry through a systematic process of school-community-business inter-cooperation.
8. To provide a system of instruction that is fully responsive to and perceptive of the intrinsic nature of change and innovation in highly technical occupations and disciplines.

TECHNICIANS DEFINED

In general the work role of the engineering technician falls between that of the vocational-industrial tradesman and that of the professional engineer. This is a broad range and is ill-defined in practice, having gray areas of work requirements at either end of the continuum and at many points in between. Perhaps the best way to define a technician is by a summary of tasks performed and the accompanying skills required. This must of necessity be done in a broad and generalized fashion with provisions for more specificity left to individual job descriptions.

Special Abilities

It is generally agreed that the engineering technician must have the following kinds of special skills and abilities:

1. Proficiency in use of the disciplined and objective scientific method in practical application of the basic principles, concepts, and laws of physics as they comprise the scientific base for the individual's field of technology.

2. Facility with mathematics; ability to use algebra and trigonometry as problem-solving tools in the development and definition of, or to quantify, scientific phenomena or principles; and, when needed, an understanding of - though not necessarily facility in - higher mathematics through analytical geometry and some calculus according to requirements of the technology.
3. A thorough understanding and facility in the use of materials, processes, apparatus, procedures, equipment, methods, and techniques commonly used in the technology.
4. An extensive knowledge of a field of specialization with an understanding of applications of the underlying physical sciences as they relate to the engineering or industrial processes, or research activities that distinguish the technology of the field. The degree of competency and depth of understanding should be sufficient to enable technicians to establish effective rapport with scientists, managers, and engineers with whom they work and to enable them to perform a variety of detailed scientific or technical work as outlined by general procedures or instructions, but requiring individual judgment, initiative, and resourcefulness in the use of techniques, handbook information, and recorded scientific data.
5. Communication skills that include the ability to record, analyze, interpret, and transmit facts and ideas with complete objectivity orally, graphically, and in writing.

Activities Performed

Technicians are expected to perform work tasks and/or support to engineers related to any of a combination of the following kinds of activities:

1. Applies knowledge of science and mathematics extensively in rendering direct technical assistance to physical scientists or engineers engaged in scientific research and experimentation.
2. Designs, develops, or plans modifications of new products, procedures, techniques, processes, or applications under supervision of scientific or engineering personnel in applied research, design, and development.

3. Plans, supervises, or assists in installation and inspection of complex scientific apparatus, equipment, and control systems.
4. Advises regarding operation, maintenance, and repair of complex apparatus and equipment with extensive control systems.
5. Plans production or operations as a member of the management unit responsible for efficient use of manpower, materials, money, and equipment or apparatus in mass production or routine technical service.
6. Advises, plans, and estimates costs as a field representative of a manufacturer or distributor of technical apparatus, equipment, services, and/or products.
7. Assumes responsibility for performance of tests of mechanical, hydraulic, pneumatic, electrical, or electronic components or systems in the physical sciences; and/or for determinations, tests and/or analyses of substances in the physical and other engineering-related sciences; and prepares appropriate technical reports covering the tests.
8. Prepares or interprets engineering drawings and sketches, or writes detailed scientific specifications or procedures for work related to physical sciences.
9. Selects, compiles, and uses technical information from references such as engineering standards, procedural outlines, and technical digests of research findings.
10. Analyzes and interprets information obtained from precision measuring and recording instruments and/or special procedures and techniques and makes evaluations upon which technical decisions are based.
11. Analyzes and diagnoses technical problems that involve independent decisions. Judgment requires, in addition to technical know-how, substantive experience in the occupational field.
12. Deals with a variety of technical problems involving many factors and variables that require an understanding of applied scientific and technical understanding - the antithesis of narrow specialization.

It is recognized that no two-year technical training program will be sufficient to prepare engineering technicians for all the problems they will encounter in the workplace. The training should however be sufficient to:

1. Provide occupational skills that are compatible with at least entry-level employment in the chosen field.
2. Provide a broad base of knowledge in science, mathematics, and technical subjects that will allow the technician to progress to higher levels of job competence in an environment characterized by rapid change and innovation.

FACULTY AND STAFF

Faculty and staff for a technical education program, particularly one offered in an existing postsecondary vocational institution, should be typified by two things:

1. A baccalaureate-degree-level education in one of the physical sciences, in engineering, or in a related technology.
2. The overall flexibility to teach a variety of courses including math and physics as well as technical laboratory courses.

To meet accreditation requirements, at least two staff members must be assigned to the Engineering Technology Department on a full-time basis. The majority of the staff must have either Master's degrees in their fields or be Registered Professional Engineers. Additional staff may be obtained from other departments, including general education, math, and other sciences. Teachers in technical courses who are skilled artisans, or journeymen in a particular area should be utilized to teach courses appropriate to their expertise.

It is essential that the staff of an engineering technology department be aware of the interdisciplinary nature of a modern technical training program. Virtually all areas dealt with by technicians involve systems of variously-arranged electrical, electronic, mechanical, fluidal, thermal, and other physical components. Willingness of the staff to work with persons from other disciplines to develop a comprehensive program is essential. Additionally, the engineering technology staff must demonstrate willingness to form close relationships with practicing engineers, technicians, and other specialists in industries using the technology in question.

The initiative to develop these sorts of relationships is absolutely essential to the exchange of information concerning state-of-the-art equipment

and processes necessary to maintain the currency and relevance of the training program.

ACCREDITATION

All institutions in a public school system are obligated to meet standards established by national and regional educational accreditation boards. Of importance to engineering technology programs, however, is credibility with the engineers and specialists with whom the technician must work. A well-recognized agency for programs in engineering technology is the Accreditation Board for Engineering and Technology (ABET), formerly known as the Engineering Council for Professional Development (ECPD). Guidelines for curriculum development, staff, student admission, degrees awarded, nomenclature associated with program graduates, and many other factors are stipulated in ABET standards. Any program seeking to prepare professional technicians should conform to ABET guidelines if it is to be accepted by industry. To do less would be unfair to students and detrimental to the field of engineering technology. All recommendations for program organization in this document are intended to meet or exceed ABET standards. Achievement of ABET accreditation cannot be obtained until a program produces graduates and the graduates are employed for an interval of time.

SECTION II
CURRICULUM ORGANIZATION

CURRICULUM ORGANIZATION

The curriculum for training the engineering technician is composed of blocks of courses, each intended to accomplish a specific purpose relative to abilities and activities necessary in the profession. To reiterate, the curriculum must be organized to provide a maximum integration of knowledge, techniques, and manipulative skills. A specific purpose of the curriculum is to provide a cognitive base of information about fundamental concepts, principles, processes, and materials associated with the technology sufficient to allow the technician to learn and acquire new skills in the context of their employment setting throughout their careers.

COURSE GROUPINGS

Basic instructional blocks and their specific purposes are as follows:

1. Basic Sciences and Mathematics

Foundations of all engineering technology programs are in the basic math and physical science areas. The percentage of courses science-to-math and the specific content will vary somewhat with the nature of the specific technology. Courses in mathematics as a general rule begin with college-level algebra and progress through the trigonometric functions and their application to technical problems. A fundamental grasp of the concepts and applications of calculus is also necesary to provide the basis for interpreting and communicating about many technical problems, solutions, and designs. Additionally, modern advances in electronic computer operation applicable to a broad range of technologies have mandated that almost every technician have a facility with the special areas of mathematics related to number systems and logical interpretation utilized in digital electronics and computer programming.

Basic science courses would include physics and/or chemistry courses that support the specified technology. Emphasis should be upon understanding, quantifying, and expressing concepts about basic phenomena of nature as they apply to the technology. Such programs should stress laboratory work and experimentation, observation, and accurate measurement and interpretation as basic quantitative tools in the study and examination of the natural world.

2. Technical Sciences (Core) Courses

Basic technical science, hereinafter referred to as technical core courses, are those technical subjects considered fundamental to a broad area of technology such as electronics, electromechanical, or mechanics. These courses are considered common to the basic understanding of engineering technology and to developing the underlying skills necessary to practice in the field. Basic concepts such as electronics or mechanical fundamentals are covered. More increasingly, microcomputer literacy has become a tool of all technicians and should be included. Another essential area includes the skills necessary for graphical interpretation, representation, and communication of technical concepts, designs, devices, and ideas. Technical core courses are intended to provide technicians with the conceptual instruments of their field and, when combined with practical applications and an understanding of the underlying mathematical and scientific principles, prepare them for more specific training in any of the diverse specializations of modern technology.

3. Technical Specialties

Technical specialty courses focus upon the skills needed in a narrower option of a broader general technology. An example is communication as a specialization in electronics. Technical specialty courses emphasize the methods, procedures, techniques, and hardware of a specific area. Such topics could include design and graphics, construction and fabrication techniques, instrumentation, production methods, field operation, maintenance, testing, and production processes.

An essential area of technical specialization is in the application of standard engineering delevopment procedures to the specified field. A knowledge of applications of science and mathematics to the development of such things as, for example, air conditioning systems, air ducts, electronic circuit development and modification, fluid circuits, plant layout, materials handling and processing, quality assurance and control, and the like are considered mandatory for the engineering technician.

4. Technical Electives

Technical electives serve to support specific career interests of students either to strengthen their basis in fundamentals such as math, science, and computer applications, or to broaden and expand horizons toward future careers by including basics of business, accounting, management, and the like.

5. Communications, Humanities, and Social Sciences

It is essential that the engineering technician be able to effectively communicate with other professionals as well as the general public in an oral and a written fashion. Proficiency in standard grammatical and compositional usages of the English language, including such things as sentence structure, exposition, and spelling and punctuation should be required. Additionally, methods of effective written organization of ideas and clear, concise oral presentations are important in the day-to-day work of the technician.

Humanities and social science courses serve to broaden the perspective of technicians and cause them to work more effectively as members of a technical team. Courses dealing with business organization and socio-economic fundamentals are considered important, as are courses that prepare the technician to deal with the affective and interpersonal situations of the workplace.

MINIMUM CREDIT REQUIREMENTS

A minimum of 100 quarter hours is required for accreditation of engineering technology programs by ABET. Of this total the following breakdown by area should apply:

- Technical Core, Technical Specialty and Technical Electives
  50 quarter hours
- Basic Science and Math
  25 quarter hours
- Communication, Humanities, and Social Sciences
  14 quarter hours
- Other Electives and/or Local Requirements
  Quarter hours vary to meet local needs.

Remember that these are minimum requirements and may not be sufficient to meet all needs.

CURRICULUM DEVELOPMENT

Currency and relevance in the engineering technology curriculum is critical to program success. Technicians trained inadequately or in outdated programs will quickly prove unproductive in the modern technical environment. The potential for waste of human resources through inadequate curriculum research and development is enormous. The following outline of procedures is considered the minimum investment of time and effort necessary for development of an engineering technology curriculum.

Research

Initial development of an engineering technology program requires that an in-depth analysis of the technology be made. Fortunately, resources are available that greatly facilitate this process. The following areas, though somewhat interrelated, represent major topical divisions of the research process.

1. State of the Art - An analysis of exactly what practices and trends in procedures, processes, techniques, equipment, and so on exist in a given technology is of course critical to curriculum development. Methods of accomplishing a state-of-the-art analysis include (a) literature review, (b) contact with professional and educational organizations, (c) surveys and interviews with related industries, (d) contact with Departments of Labor and Education at the state and federal level. A compilation of a state-of-the-art review can form the foundation for a purpose and mission statement for development of an engineering technology program.
2. Workforce Analysis - Workforce needs for technicians in a given category should be thoroughly assessed in conjunction with the state-of-the-art review. As obvious as this seems, it is often a sorely neglected procedure.

   There are at least two sources of workforce information that should be tapped: (1) workforce forecasting and occupational information available from the U.S. Department of Labor and related state and

regional agencies, (2) projection of local industries of need for technical-level employees. These data can and should be collected in conjunction with the state-of-the-art review.

3. Existing Programs - Whenever possible, institutions offering similar technology programs should be contacted for input on existing courses and materials they are employing. There is seldom a need to reinvent the wheel in the matter of curricula and instructional development. Many institutions involved in technical education are forming networks and consortia to routinely share information on new and emerging aspects of the technology.

4. Task Analysis - Design and content of technical specialty courses depend on the nature of the work performed by incumbent technicians in a given field. The only valid method for developing a course that teaches the skills, techniques, and abilities required is to conduct a task analysis of each job title for which technicians are trained. The task analysis procedure breaks down or outlines a job into its functional areas, discrete responsibilities, and component steps. The process of task analysis yields data about required skill and competencies of a given job around which instructional units and courses can be built. Major steps in the task analysis may be outlined as follows:

   Gather task data from existing sources.

   Review text materials for task information.

   Compile an occupational inventory that "laundry lists" tentative tasks.

   Interview and observe practicing technicians and their supervisors to validate tasks on issues such as currency, relevance, frequency of performance, criticality, terminology.

   Develop and validate lists of tasks suitable for the type of training situation planned.

   "Detail" tasks by identifying sequential procedural steps involved in each.

   Identify skills and competencies from task detailing information.

   Develop courses that teach skills and competencies identified by task analysis procedures.

Advisory Committee

The key to developing an effective occupational training program in any area is maintaining contact with employers who ultimately will hire the trainees. Technical education can no more ignore the concerns of these consumers of the educational product than General Motors can ignore the concerns of the American car buyer.

Advisory committees for curriculum development work should not be developed to serve a public relations function. Contacts between instructors, administrators, and advisory members should occur on a routine basis. Informal as well as formal relationships should be developed. Visitations by school personnel to industry and by industrial personnel to schools should be a common and frequent occurrence. The cost-effectiveness of good technical training is a major concern to educators and industrial managers alike. Open pathways between educational institution and workplace will add immeasurably to the ability of formalized education and training to meet employment requirements vital to industry and essential to the career development of the student population.

MATERIALS DEVELOPMENT

The business of developing materials for technical education programs is a vast and highly sophisticated area. Commercial publishers have expended millions of dollars in the design and development of technical curricula, and many excellent publications are presently available.

Analysis

The intent here is to review cogent points that any instructor or institution should bear in mind as curriculum materials are either adapted or locally developed. This process should follow the general outline below:

1. Examine task analysis and task detailing work carefully.
2. Identify skills and competencies that support tasks performed by technicians in the field.
3. Write a topical outline of courses to teach these skills and competencies.
4. Write a course description for each course.

5. Write behavioral student objectives for each course.
6. Write a detailed outline of topics to be covered to accomplish objectives.
7. Specify lab exercises and hands-on task performances that will support the learning objectives.
8. Review existing commercial materials for adaptation based on their ability to meet course objectives.
9. Develop materials locally to meet specialized needs.

Note that this model defers selection of materials until a thorough analysis of the technician's job role has been made. Good curriculum development does not allow the material to shape programs, but rather utilizes material to meet an assessed and documented need. While this may seem a somewhat minor distinction, it is characteristic of training efforts that are concerned about relevance and efficiency.

Technical Core Courses

Technical core courses must be carefully selected so that they cover the fundamental concepts, principles, devices, and processes common to specialization areas within the technology that are to be made available as curriculum options. Technical core courses must be seen as another building block of knowledge and skills, building upon competencies in math and science, and toward a hands-on ability in dealing with specialized systems. These courses are taught in most institutions already, and the internal development process will be facilitated by availability of commercial texts and other materials in such areas as basic electronics, graphics and design, mechanical devices and systems, fluid power, and so forth. The key to development of core courses is careful organization of topics into outline form and development of specific student competencies before materials are selected and laboratory experiments are designed. It is toward this sort of specificity in course design that this document is intended.

Technical Specialty Courses

Development of specialty courses in new and emerging technologies such as robotics or telecommunications, to name only two, should not be attempted without a heavy input of technical expertise and advisement. The process of developing materials in these areas requires that the specialty area be researched in detail and that persons intrinsically familiar with the technology be utilized to select or develop materials that will form course content. It is almost a certainty that the typical education institution must look outside its own doors for experience and expertise to develop course materials for these courses. Currency of materials is always a problem in technology, and the use of state-of-the-art experts is necessary if this currency is to be obtained.

Formatting

Courses developed in technical subjects must be flexible to be easily updated as the technology changes. For this reason, a modularized format with each course developed around identified skill or competency blocks is highly desirable. A typical module should consist of the following items:

Introduction - Identifies topics of the module and gives some background rationale for its inclusion into the instructional program.

Module Prerequisites - Identifies knowledge and skills students should possess before studying the module and specifies previous course work relevant to these knowledges and skills.

Objectives - Clearly states what the student should know and be able to do as a result of studying a particular module. These objectives should be stated in behavioral form with an emphasis on student actions that indicate that the learning has in fact taken place.

Subject Matter - Presents background theories and techniques that support the objectives.

Exercises - Provides practical problems to which knowledge gained from study can be applied. Includes all out-of-class assignments.

Specialized Learning Activities - Refers student to prior prepared supplemental learning experiences that support module objectives where appropriate. These may consist of such things as audiovisual materials, independent library work, group activities, and the like.

Laboratory Materials - Lists equipment necessary to complete laboratory procedures.

Laboratory Procedures - Presents experiments or "hands-on" activities for lab work. Includes step-by-step instruction and identifies necessary instructor check points.

References - Directs the student to sources of supplemental information. Includes print and nonprint media as well as resource persons or agencies.

Test - A criteria-referenced examination that measures achievement against stated objectives.

SECTION III

CURRICULUM DESIGN

This section contains several exhibits that illustrate the organization of the total curriculum, including instructional blocks, specialization course titles, schedules, and course numbers.

Exhibit 1 - Basic instructional areas with breakdown of quarter hours and contact hours.

Exhibit 2 - Three broad areas of technology covered, with specialization options available.

Exhibits 3, 4, and 5 - Itemization of core courses in the three technologies.

Exhibit 6 - Matrix of courses comparing curriculum commonalities.

Exhibits 7, 8, and 9 - Seven-quarter scheduling outline for the three technologies.

Exhibit 10 - A recommended alphanumeric coding system with departmental designations.

EXHIBIT 1
ASSOCIATE DEGREE PROGRAM
ENGINEERING TECHNOLOGY
BASIC CURRICULUM STRUCTURE

	Quarter Hours	Contact Hours
Communications, Humanities, Social Science		
Economics	5	50
Technical Communications	5	50
English and Composition	5	50
Industrial Relations	5	50
	20	200
Basic Science and Math		
Physics	15	270
Math for Engineering Technicians	15	150
	30	420
Technical Science Core		
Varies by program 10 to 12 courses	58 (Avg)	420 (Avg)
Technical Specialty Courses		
Varies by program 5 to 8 courses	30 (Avg)	250 (Avg)
Electives		
(Selected as appropriate) Varies by program	5-10	50-100
Total	143	1720

EXHIBIT 2
ENGINEERING TECHNOLOGY CURRICULUM
PROGRAM OPTIONS
ASSOCIATE DEGREE PROGRAM

ELECTROMECHANICAL ENGINEERING TECHNOLOGY

- Electrical Technology
- Robotics
- Instrumentation and Industrial Control
- Electromechanical Technology

ELECTRONIC ENGINEERING TECHNOLOGY

- Industrial Electronics
- Computer Applications
- Communications
- Avionics

MECHANICAL ENGINEERING TECHNOLOGY

- Mechanical Technology (Production)
- Mechanical Technology (Design)

EXHIBIT 3
ELECTROMECHANICAL CORE

Options

Electrical Technology
Electromechanical Technology
Instrumentation and Industrial Control
Robotics

Common Courses	Class	Lab	Credit
*Fundamentals of Engineering Technology	3	4	3
*Computer Fundamentals	3	4	5
*Engineering Graphics	1	6	3
*Fundamentals of Electricity and Electronics (DC and AC)	3	4	5
Electronic Devices	3	4	5
*Electromechanical Devices	3	4	5
Electrical Power	2	5	4
Mechanical Devices and Systems	2	2	3
Fluid Power	2	5	4
Instrumentation and Controls	2	4	5
Heating and Cooling Systems	3	4	5
Digital Electronics	3	4	5
Computer Applications	3	4	5

Technical Specialty

Four courses to be added

*Courses common to three technologies

EXHIBIT 4
ELECTRONICS CORE

Options

Avionics
Industrial Electronics
Computer Applications
Communications

Common Courses	Class	Lab	Credit
*Fundamentals of Engineering Technology	2	4	3
*Computer Fundamentals	3	4	5
*Engineering Graphics	1	6	3
*Fundamentals of Electricity and Electronics (DC and AC)	3	4	5
Circuit Analysis (DC and AC)	2	6	4
Electronic Devices	3	4	5
*Electromechanical Devices	3	4	5
Electronic Communications	2	5	4
Linear Integrated Circuits	2	5	4
Digital Fundamentals	3	4	5
Computer Applications	3	4	5
Materials and Processes	3	4	5
Two courses to be added			

Technical Specialty

Five courses to be added

*Courses common to three technologies

EXHIBIT 5
MECHANICAL TECHNOLOGY CORE

Options

Mechanical Technology (Production)
Mechanical Technology (Design)

Common Courses	Class	Lab	Credit
*Fundamentals of Engineering Technology	2	4	3
*Computer Fundamentals	3	4	4
*Engineering Graphics	1	6	3
*Fundamentals of Electricity and Electronics (DC and AC)	3	4	5
Manufacturing Processes I	1	6	3
Mechanical Drives	3	4	5
Mechanical Linkages and Machines	2	5	4
*Electromechanical Devices	3	4	5
Fluid Power	2	5	4
Strength of Materials	3	4	5
Metallurgy	3	4	5
Manufacturing Processes II	3	4	5

Technical Specialty

Five courses to be added

*Courses common to three technologies

EXHIBIT 6
MATRIX OF COURSES COMPARING CURRICULUM COMMONALITIES

	ELT	EMT	MET
COMMUNICATIONS, HUMANITIES, SOCIAL SCIENCES			
Principles of Economics	x	x	x
Industrial Relations	x	x	x
English and Composition	x	x	x
Technical Communications	x	x	x
BASIC SCIENCE AND MATH			
Physics I	x	x	x
Physics II	x	x	x
Physics III	x	x	x
Algebra	x	x	x
Trigonometry	x	x	x
Analytic Geometry and Calculus	x	x	x
TECHNICAL SCIENCE CORE			
Engineering Graphics	x	x	x
Computer Fundamentals	x	x	x
Computer Applications	x	x	
Fundamentals of Electricity and Electronics (DC and AC)	x	x	x
Circuit Analysis	x		
Electrical Power		x	
Electromechanical Devices	x	x	x
Electronic Devices	x	x	
Fluid Power		x	x
Instrumentation and Controls		x	
Mechanical Devices and Systems		x	
Mechanical Drives			x
Mechanical Linkages and Machines			x
Manufacturing Processes I			x
Manufacturing Processes II			x
Metallurgy			x
Strength of Materials			x
Materials and Processes	x		
Electronic Communications	x		
Linear Integrated Circuits	x		
Digital Electronics	x	x	
Heating and Cooling Systems		x	
TECHNICAL SPECIALTY COURSES			
Fundamentals of Engineering Technology	x	x	x
Four to six courses to be added	x	x	x

EXHIBIT 7
ELECTROMECHANICAL TECHNOLOGY
RECOMMENDED CURRICULUM - QUARTER SYSTEM

	CTass	Lab	Contact Hours	Cr
First Quarter				
Fundamentals of Engineering Technology	2	4	6	3
Computer Fundamentals	3	4	7	5
Algebra	5	0	5	5
English and Composition	5	0	5	5
	15	8	23	18
Second Quarter				
Physics I	3	6	9	5
Trigonometry	5	0	5	5
Fundamentals of Electricity and Electronics (DC and AC)	3	4	7	5
Engineering Graphics	1	6	7	3
	12	16	38	18
Third Quarter				
Electronic Devices	3	4	7	5
Physics II	3	6	9	5
Analytic Geometry and Calculus	5	0	5	5
Mechanical Devices and Systems	2	2	4	3
	13	12	25	18
Fourth Quarter				
Electrical Power and Distribution	2	5	7	4
Fluid Power	2	5	7	4
Physics III	3	6	9	5
Technical Communications	5	0	5	5
	12	16	28	18
Fifth Quarter				
Electromechanical Devices	3	4	7	5
Digital Electronics	3	4	7	5
EMT Specialty Course	2	5	7	4
Principles of Economics	5	0	5	5
	12	13	26	19
Sixth Quarter				
Heating and Cooling Systems	3	4	7	5
EMT Specialty Course	3	5	8	5
Elective	3	0	3	3
EMT Specialty Course	3	4	7	5
	12	13	25	18
Seventh Quarter				
Industrial Relations	5	0	5	5
Instrumentation and Controls	3	4	7	5
Computer Applications	3	4	7	5
EMT Problems Course	0	9	9	3
	11	17	28	18

EXHIBIT 8
ELECTRONICS TECHNOLOGY
RECOMMENDED CURRICULUM - QUARTER SYSTEM

	Class	Lab	Contact Hours	Cr
First Quarter				
Fundamentals of Engineering Technology	2	4	6	3
Computer Fundamentals	3	4	9	5
Algebra	5	0	5	5
English and Composition	5	0	5	5
	15	8	25	18
Second Quarter				
Physics I	3	6	9	5
Trigonometry	5	0	5	5
Fundamentals of Electricity and Electronics (DC and AC)	3	4	7	5
Engineering Graphics	1	6	7	3
	12	16	28	18
Third Quarter				
Electronic Devices	3	4	7	5
Physics II	3	6	9	5
Analytic Geometry and Calculus	3	0	3	3
Circuit Analysis (DC and AC)	2	6	7	4
	13	16	28	19
Fourth Quarter				
Electronic Communications	2	5	7	4
Linear Integrated Circuits	2	5	7	4
Physics III	3	6	9	5
Technical Communications	5	0	5	5
	12	16	28	18
Fifth Quarter				
Electromechanical Devices	3	4	7	5
Digital Electronics	3	4	7	5
ELT Specialty Course	3	4	7	5
Principles of Economics	5	0	5	5
	13	13	26	19
Sixth Quarter				
ELT Course to be added	3	4	7	5
ELT Specialty Course	3	5	8	5
ELT Course to be added	2	2	4	3
ELT Specialty Course	3	4	7	5
	11	15	26	18
Seventh Quarter				
Industrial Relations	5	0	5	5
Computer Applications	3	4	7	5
Materials and Processes	3	4	7	5
ELT Problems Course	0	9	9	3
	11	17	28	18

EXHIBIT 9
MECHANICAL TECHNOLOGY
RECOMMENDED CURRICULUM - QUARTER SYSTEM

	Class	Lab	Contact Hours	Cr
First Quarter				
Fundamentals of Engineering Technology	2	4	6	3
Computer Fundamentals	3	4	7	5
Algebra	5	0	5	5
English and Composition	5	0	5	5
	15	8	23	18
Second Quarter				
Physics I	3	6	9	5
Trigonometry	5	0	5	5
Fundamentals of Electricity and Electronics (DC and AC)	3	4	7	5
Engineering Graphics	1	6	7	3
	12	16	28	18
Third Quarter				
Mechanical Drives	3	4	7	5
Physics II	3	6	9	5
Analytic Geometry and Calculus	5	0	5	5
Manufacturing Processes I	1	6	7	3
	12	16	28	18
Fourth Quarter				
Mechanical Linkages and Machines	2	5	7	4
Fluid Power	2	5	7	4
Physics III	3	6	9	5
Technical Communications	5	0	5	5
	12	16	28	18
Fifth Quarter				
Electromechanical Devices	3	4	7	5
Strength of Materials	3	4	7	5
MT Specialty Course	2	5	7	4
Principles of Economics	5	0	5	5
	13	13	26	19
Sixth Quarter				
MT Specialty Course	3	4	7	5
MT Specialty Course	3	5	8	5
Elective	3	0	3	3
Metallurgy	3	4	7	5
	12	13	25	18
Seventh Quarter				
Industrial Relations	5	0	5	5
MT Specialty Course	3	4	7	5
Manufacturing Processes II	3	4	7	5
MT Problems Course	0	9	9	3
	11	17	28	18

EXHIBIT 10

ENGINEERING TECHNOLOGY CURRICULUM

DEPARTMENTAL DESIGNATIONS

AET Applied Engineering Technology
ELT Electronics Engineering Technology
EMT Electromechanical Engineering Technology
MET Mechanical Engineering Technology
PHY Physics
MAT Math

APPLIED ENGINEERING TECHNOLOGY

AET 121	Fundamentals of Engineering Technology
AET 122	English and Composition
AET 123	Computer Fundamentals
AET 221	Technical Communications
AET 222	Principles of Economics
AET 223	Industrial Relations

MATH

MAT 121	Algebra
MAT 122	Trigonometry
MAT 123	Analytic Geometry and Calculus

PHYSICS

PHY 121	Physics I
PHY 122	Physics II
PHY 123	Physics III

ELECTRONICS ENGINEERING TECHNOLOGY

ELT 121	Fundamentals of Electricity and Electronics (DC and AC)
ELT 122	Circuit Analysis
ELT 123	Electronic Devices
ELT 221	Electronic Communications
ELT 222	Linear Integrated Circuits
ELT 223	Digital Electronics
ELT 224	Computer Applications

ELT 225 Materials and Processes

(ELT 300) Electronics Engineering Technology specialty courses will be designated by 300-level numbers.

ELECTROMECHANICAL ENGINEERING TECHNOLOGY

EMT 121 Mechanical Devices and Systems

EMT 221 Electrical Power and Distribution

EMT 222 Fluid Power

EMT 223 Electromechanical Devices

EMT 224 Heating and Cooling Systems

EMT 225 Instrumentation and Controls

(EMT 300) Electromechanical Technology specialty courses will be designated by 300-level numbers.

MECHANICAL ENGINEERING TECHNOLOGY

MET 121 Engineering Graphics

MET 122 Mechanical Drives

MET 123 Manufacturing Processes I

MET 221 Mechanical Linkages and Machines

MET 222 Strength of Materials

MET 223 Metallurgy

MET 224 Manufacturing Processes II

(MET 300) Mechanical Engineering Technology specialty courses will be designated by 300-level numbers.

SECTION IV

CURRICULUM CONTENT

This curriculum content section includes complete outlines of courses for the first year of the three curricula, with related student competencies, recommended texts, and suggested laboratory activities.

Course	Page
Algebra	37
Analytic Geometry and Calculus	40
Circuit Analysis	43
Computer Fundamentals	46
Electrical Power Distribution	49
Electronic Devices	54
Engineering Graphics	57
English and Composition	59
Fluid Power	61
Fundamentals of Electricity and Electronics (DC and AC)	67
Fundamentals of Energy Technology	70
Manufacturing Processes I	73
Mechanical Devices and Systems	79
Mechanical Drives	85
Physics I	89
Physics II	99
Physics III	106
Technical Communications	114
Trigonometry	117

ALGEBRA

COURSE DESCRIPTION

This course is designed to develop and update algebraic skills required for engineering technicians as applied to the solution of practical problems encountered in electrical, mechanical, thermal, hydraulic, pneumatic and optical technologies. Topics to be covered include functions and graphs, exponents, radicals, linear equations, determinants, factoring, quadratics, and various techniques for solutions of equations and systems of equations.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Fundamental Concepts and Operations	10	
A. Numbers and Literal Symbols		
B. Fundamental Laws of Algebra		
C. The Laws of Exponents		
D. Scientific Notation		
E. Exponents and Radicals		
F. Addition and Subtraction of Algebraic Expressions		
G. Multiplication and Division of Algebraic Expressions		
H. Equations and Formulas		
II. Functions and Graphs	5	
A. Functions		
B. Cartesian Coordinates		
C. Graphing Functions		
D. Solving Equations Graphically		
III. Linear Equations and Determinants	10	
A. Linear Equations		
B. Graphical Solution of Systems of Two Linear Equations in Two Unknowns		
C. Algebraic Solution of Systems of Two Linear Equations in Two Unknowns		
D. Solution by Determinants of Systems of Two Linear Equations in Two Unknowns		
E. Algebraic Solutions of Three Linear Equations in Three Unknowns		
F. Solution by Determinants of Systems of Three Linear Equations in Three Unknowns		
IV. Factoring and Fractions	10	
A. Special Products		
B. Factoring		
C. Simplifying Fractions		
D. Multiplication and Division of Fractions		
E. Addition and Subtraction of Fractions		

	Student Contact Hours	
	Class	Laboratory
V. Quadratic Equations	5	
A. Quadratic Equations. Solution by Factoring		
B. Completing the Square		
C. The Quadratic Formula		
VI. Exponents and Radicals	6	
A. Positive Integers as Exponents		
B. Zero and Negative Integers as Exponents		
C. Fractional Exponents		
D. Simplest Radical Form		
E. Addition and Subtraction of Radicals		
F. Multiplication and Division of Radicals		
VII. Additional Solutions to Equations and Systems of Equations	6	
A. Graphical Solution of Systems of Equations		
B. Algebraic Solution of Systems of Equations		
C. Equations in Quadratic Form		
D. Equations with Radicals		

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

I. Fundamental Concepts and Operations
- Write concepts mathematically using numbers and symbols.
- Perform mathematical operations using the fundamental laws of algebra and the laws of exponents.
- Make mathematical computations using scientific notation.
- Perform algebraic operations of addition, subtraction, multiplication, and division on algebraic terms.
- Perform basic mathematical operations on equations and formulas to solve for any given variable.

II. Functions and Graphs
- Graph equations and functions with two variables.
- Solve system of equations graphically.

III. Linear Equations and Determinants
- Graphically solve two linear equations with two unknowns.
- Algebraically solve two linear equations with two unknowns.
- Use determinants to solve two linear equations with two unknowns.
- Algebraically solve three linear equations with three unknowns.
- Using determinants solve three linear equations in three unknowns.

IV. Factoring and Fractions
- Identify the general form of first, second, and third degree equation products of two variables.
- Factor into prime factors algebraic expressions containing common monomial factors.
- Factor the difference of two squares.
- Factor trinomial expressions.

- Change a given algebraic fraction into a specified equivalent fraction.
- Perform operations of addition, subtraction, multiplication and division on algebraic fractions.
- Solve equations containing algebraic fractions.

V. Solution of Quadratic Equations
- Solve quadratic equations by factoring.
- Solve quadratic equations by completing the square.
- Solve quadratic equations by use of the quadratic formula.

VI. Exponents and Radicals
- Perform operations involving algebraic expressions with integral exponents.
- Perform operations involving algebraic expressions containing fractional exponents.
- Reduce radicals to simplest form.
- Perform operations with algebraic expressions containing radicals.

VII. Additional Types of Equations and Systems of Equations
- Graphically solve systems of first and second degree equations with two variables.
- Algebraically solve systems of first and second degree equations with two variables.
- Solve equations that are in quadratic form.
- Solve equations containing radicals.

RECOMMENDED TEXTS

Clar and Hart. Mathematics for the Technologies. Englewood Cliffs, NJ: Prentice-Hall.

Paul and Shaevel. Essentials of Technical Mathematics with Calculus. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Washington, Allyn J. Basic Technical Mathematics With Calculus. 3rd ed. Benjamin Cummings.

ANALYTIC GEOMETRY AND CALCULUS

COURSE DESCRIPTION

This course is designed to develop analytic geometry and calculus skills required for engineering technicians as applied to the solution of practical problems encountered in electrical, mechanical, thermal, hydraulic, pneumatic, and optical technologies. Topics to be covered include analytic geometry, derivative, integration, differentiation of transcendental functions and integration techniques.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Elements of Analytic Geometry	12	
A. The Straight Line		
B. The Circle		
C. The Parabola		
D. The Ellipse		
E. The Hyperbola		
F. Polar Coordinates		
II. Derivatives and Applications	10	
A. Limits		
B. The Slope of a Tangent to a Circle		
C. The Derivative		
D. Derivatives of Polynomials		
E. Derivatives of Products and Quotients of Functions		
F. The Derivative of a Power of a Function		
G. The Derivative as a Rate of Change		
H. Maximum and Minimum Problems		
III. Integration and Applications	10	
A. Differentials and Inverse Differentiation		
B. The Indefinite Integral		
C. The Area Under a Circle		
D. The Definite Integral		
E. Finding Areas by Integration		
F. Trapezoidal Rule for Approximating Areas		
G. Volumes by Integration		
H. Applications of the Integral		
IV. Differentiation of Transcendental Functions	10	
A. Derivatives of the Sine and Cosine Functions		
B. Derivatives of the Other Trigonometric Functions		
C. Derivatives of the Inverse Trigonometric Functions		
D. Derivatives of the Logarithmic Function		

	Student Contact Hours	
	Class	Laboratory
V. Integration Techniques	10	
A. The General Power Formula		
B. The Logarithmic and Exponential Form		
C. Basic Trigonometric Forms		
D. Integration by Parts		
E. Integration by Substitution		
F. Use of the Tables		

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

I. Elements of Analytic Geometry
- Find the straight-line distance between two points on a graph.
- Define and find the slope of a line.
- Write the equation of a straight line given various properties of the line such as points on the line, slope, and/or intercepts.
- Define a circle and write the equation of a circle with the center at (0,0) and with the center at any coordinate (x,y).
- Define and derive the equation of a parabola given appropriate data.
- Define and derive the equation of an ellipse given appropriate data.
- Define and derive the equation of a hyperbola given appropriate data.
- Convert from rectangular to polar coordinates.

II. Derivatives and Applications
- Determine if a function is continuous.
- Determine the limits of a function if they exist.
- Find the slope of the tangent to a curve.
- Define and find the derivative of a function.
- Find the derivative of a polynomial by the Δ-process.
- Derive the derivatives of products and quotients of functions.
- Derive the derivative of a power of a function.
- Use differential calculus to solve problems involving rate of change.
- Use differential calculus to solve maximum and minimum problems.

III. Integration and Applications
- Find the differential of a function.
- Find the antiderivative of a function.
- Define and find the indefinite integral of a function.
- Find the area under a curve.
- Define the definite integral of f(n).
- Find the curve under a curve by integration.
- Use the trapezoidal rule for approximating the area under a curve.
- Find volumes by integration.
- Apply integral calculus to solve problems involving moments of inertia, work, average values, etc.

IV. Differentiation of Transcendental Functions
- Compute derivatives of the sine and cosine functions.
- Compute derivatives of the other trigonometric functions.
- Compute derivatives of the inverse trigonometric functions.

- Compute derivatives of the logarithmic functions.

V. Integration Techniques
- Integrate functions by use of the general power formula.
- Integrate functions in logarithmic and exponential form.
- Integrate the trigonometric functions.
- Perform integration by parts.
- Perform integration by substitution.
- Perform integration by use of tables.

RECOMMENDED TEXT

Clar and Hart. Mathematics for the Technologies. Englewood Cliffs, NJ: Prentice-Hall.

Paul and Shaevel. Essentials of Technical Mathematics with Calculus. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Washington, Allyn J. Basic Technical Mathematics With Calculus. 3rd ed. Benjamin Cummings.

CIRCUIT ANALYSIS

COURSE DESCRIPTION

An in-depth application of dc and ac circuit fundamentals to give the student experience in dc and ac circuit analysis using equivalent circuits, resistance networks, series and parallel impedances, impedance networks and resonance circuits by use of mathematical analysis and lab projects.

COURSE OUTLINE

		Student Contact Hours	
		Class	Laboratory
I.	Equivalent Circuits	4	12
	A. Circuit Analysis Techniques		
	B. Equivalent Circuits		
	C. Constant Voltage Sources		
	D. Thevenin's Theorem		
	E. Constant Current Sources		
	F. Norton's Theorem		
	G. Delta-Wye Transformation		
	H. The Wheatstone Bridge		
II.	Resistance Networks	4	12
	A. Network Equations for Kirchhoff's Law		
	B. Kirchhoff's Voltage-Law Equations -- Loop Procedure		
	C. Networks with More than One Voltage Source		
	D. Loop Equations in Multisource Networks		
	E. The Superposition Theorem		
	F. Nodal Analysis		
	G. Thevenin's Theorem in Multisource Networks (Millman's Theorem)		
III.	Series and Parallel Impedance	4	12
	A. Resistance and Impedance		
	B. Impedance in Series - Kirchhoff's Current Law		
	C. Impedance in Parallel - Kirchhoff's Current Law		
	D. Series-Parallel Impedances		
	E. Equivalent Circuits		
	F. Maximum Power Transfer		
	G. Circle Diagrams		
IV.	Impedance Networks	4	12
	A. Loop Equations		
	B. The Superposition Theorem		
	C. Thevenin's Theorem and Norton's Theorem		
	D. Nodal Analysis		
	E. Delta-Wye Transformation		
	F. Alternating Current Bridges		

	Student Contact Hours	
	Class	Laboratory
V. Resonance	4	12
A. Effect of Varying Frequencies in a Series RLC Circuit		
B. Series Resonance		
C. Q of Resonance Rise of Voltage		
D. Selectivity		
E. The Theoretical Parallel-Resonant Circuit		
F. Practical Parallel-Resonant Circuit		
G. Selectivity of Parallel-Resonant Filter Networks		
H. Resonant Filter Networks		

STUDENT LABORATORIES

I. Equivalent Circuits
- Analyze multiple source networks using Thevenin's theorem.
- Make an analysis of multiple-source networks using Norton's theorem.
- Illustrate and study a Delta-Wye transformation.

II. Resistance Networks
- Analyze several dc networks with multiple sources using Kirchhoff's voltage law, superposition, nodal analysis, and Millman's theorem.

III. Series and Parallel Impedance
- Plot and study characteristics of series impedance RC and RL circuits.
- Plot and study characteristics of parallel impedance RC and RL circuits.
- A study of power factor measurements and corrections.

IV. Impedance Networks
- Analyze impedance networks using loop equations.
- Make analysis of impedance network using Delta-Wye transformation.
- Analyze several ac networks with multiple sources using network theorems.

V. Resonance
- Construct a series resonant circuit and identify the following parameters: bandwidth, Q, θ, resonant frequency, selectivity, half-power point, I_T, E_T, and Z.
- Construct a parallel resonant circuit - same as above.
- Be able to identify high pass filter networks, low pass filter networks, band pass filter networks, and band stop filter networks.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Solve for parameters of a given circuit to include E_{TH}, R_{TH}, I_N, R_N, and simplified circuit, by using circuit analysis techniques including Thevenin's and Norton's theorems.

- Analyze resistance networks using: Kirchhoff's voltage law, superposition, nodal analysis, and Millman's theorem.
- Plot and study characteristics of series and parallel impedance circuits using Kirchhoff's current law, circle diagrams, and power transfer factor to include: θ, I_T, Z_T, and PF.
- Analyze parameters of impedance networks using loop equations, Delta-Wye transformation, and network theorems.
- Analyze series and parallel resonant circuits and solve for the following parameters: bandwidth, Q, $\theta°$, resonant frequency, selectivity, half-power point, I_T, E_T, Z.

SUGGESTED TEXTS

Jackson, Herbert W. Introduction to Electric Circuitry. 5th ed. Englewood Cliffs, NJ: Prentice-Hall Publishing Co.

Boylstad, Robert D. Introductory Circuit Analysis. 4th ed. Bobs Merrill Publishing Company.

COMPUTER FUNDAMENTALS

COURSE DESCRIPTION

This course will provide students with knowledge, skills, and attitudes to use the microcomputer as a tool to solve engineering technology problems typically encountered throughout their programs. Topics taught will include microcomputer architecture, programming concepts, branching, looping, arrays, functions, subroutines, data files, graphics and applications.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Introduction to the Microcomputer	2	3
A. Hardware		
B. Terminology		
C. Execution Modes		
D. Programs		
II. Introductory Concepts of Programming	4	6
A. Flowcharting		
B. Variable Types		
C. Operations and Formulas		
D. Simple BASIC Programming		
E. Program Comments		
F. Storage and Retrieval of Programs		
III. Branching and Looping	3	4
A. Relational Operations		
B. Logical Operations		
C. Conditional Branching		
D. Multiple Branching		
E. The Stop Statement		
F. Loops		
G. Nested Loops		
IV. Arrays	3	4
A. Lists and Tables		
B. Subscripted Variables		
C. Defining Arrays		
V. Functions and Subroutines	3	4
A. Library Functions		
B. User Functions		
C. Defining		
D. Random Numbers		
E. Defining Subroutines		
F. Referencing Subroutines		
VI. Data Files	3	4
A. Creating Sequential Data Files		
B. Using Sequential Data Files		

	Student Contact Hours	
	Class	Laboratory
C. Random Data Files D. File Specifications		
VII. Graphics A. Drawing Bar Charts B. Graphing Functions C. Computer-Generated Imagery	3	4
VIII. Engineering Applications A. Electronic Technology Problems B. Electromechanical Technology Problems C. Mechanical Technology Problems	3	12
IX. Other Microcomputer Applications A. Word Processing B. Computer Games C. Computer-Generated Experiments D. Interfacing	3	4

STUDENT LABORATORIES

- Execute instructor-supplied simple programs.
- Develop, debug, and execute simple BASIC programs.
- Save, retrieve, and execute a previously developed BASIC program.
- Create a data file, develop a program that will manipulate the file, and produce an acceptable output.
- Given a typical engineering problem including all necessary equations and data, develop programs that will solve the problems and produce acceptable outputs.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Identify microcomputer hardware and define the associated terms.
- Execute simple demonstration programs.
- Write, save, retrieve, and execute simple programs in BASIC.
- Write BASIC programs using branching and looping statements.
- Write BASIC programs manipulating data using arrays.
- Write BASIC programs using library functions.
- Develop functions and subroutines and incorporate them into BASIC programs.
- Write programs that use and manipulate data files.
- Solve selected technology problems using the microcomputer.

RECOMMENDED TEXT

Bent, Robert J. and Sethares, George C. BASIC: An Introduction to Computer Programming. 2nd ed. Monterey, CA: Brooks/Cole Publishing Co., 1982.

Shelly, Gary B., Cashman, Thomas J. Introduction to BASIC Programming. Brea, CA: Anaheim Publishing Co., 1982.

48

ELECTRICAL POWER DISTRIBUTION

COURSE DESCRIPTION

Electrical Power Distribution presents fundamentals of polyphase, ac circuits, electrical generating equipment, transmission, and distribution systems. Emphasis is placed on equipment and components used in industrial distribution systems, transformers, switch gears, conduits, metering, fault and overload protection and reactance compensation of various loads for power factor correction and the reading/sketching of schematics. Students will examine several power systems in operation and recognize the relations of the various components and equipment.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Polyphase AC Circuits	4	10
A. Review of Single-Phase, AC Circuits		
1. Current, voltage, reactance, impedance		
2. Vector diagram representation of current and voltage, phase lag		
3. Apparent power, real power, power factor		
B. Three-Phase, Four-Wire Circuit		
C. Balanced Y-Connected Leads		
D. Polyphase Vector Diagrams		
E. Unbalanced Y-Connected Leads		
F. Delta-Connected Leads		
G. Measurement of Power in Three-Phase Systems		
H. Three-Phase Ratings		
II. Generating Electric Power	2	4
A. Prime Movers		
1. Steam turbine		
2. Gas turbine		
3. Hydro		
4. Diesel engine		
B. Generators		
1. Classification		
a. Vertical-horizontal		
b. Speed		
c. Capacity		
Utility-industrial		
III. Switching and Transmission	2	4
A. Breakers and Switches (Basic Transmission Plus Losses)		

	Student Contact Hours	
	Class	Laboratory
B. Step-Up Transformers and Transformer Connections (Power Transmission)		
1. Voltage levels		
2. Capacity		
3. Metering		
a. Ac circuits		
b. Three-phase including PF correction		
4. Protection		
C. Transmission Lines		
1. Conductor sizes		
2. Poles and towers		
3. Insulators		
4. Protection		
5. Voltages		
IV. Step-Down Transformer Substation	4	10
A. Voltage Levels		
B. Switching and Distribution		
1. Controls		
2. Metering		
C. Industrial and Commercial Circuits		
1. Voltage levels		
2. Metering		
3. Rate schedules		
a. Usage		
b. Demand		
c. Fuel adjustment		
D. Residential Circuits		
V. Power Distribution - Industrial (Purchased Power)	4	12
A. Unit Substations		
1. High-voltage section (auto transmission and other transmission)		
2. Transformer section		
3. Low-voltage section		
B. Metering Control and Protection		
1. kWh - watt - volt - (indicating and recording)		
2. Overload - short circuit - ground fault		
3. Demand - PF correction		
C. Distribution		
1. Conduit and cable		
2. Interlocked armor		
3. Aerial cable - messenger		
4. Bus duct		
D. Power Substations (Generated Power)		
1. High-voltage motor line starters		

	Student Contact Hours	
	Class	Laboratory
2. Transformers (13.8 kV/2300 V) a. Primary-disconnect, fusible b. Metering 3. Transformers (13.8 kV/460 V) a. Low-voltage breakers b. Distribution bus 4. Low-voltage motor control centers a. Incoming line compartment b. Vertical section 1. Individual motor line Starter sizes - 1 through 5 (IPs) 2. Special circuits Welding Heating Air conditioning 3. Lighting and receptacles Main breaker - transformer - Distribution panel		
VI. Schematic Diagram - Power Distribution and Troubleshooting A. Diagram 1. Symbols 2. Circuits 3. Metering B. Troubleshooting 1. Transformers 2. Switchgear	4	10

STUDENT LABORATORIES

- Examine the electrical distribution and switchgear system at the school and draw a schematic to accurately represent this system, identifying major components, and locations.
- Examine the electrical distribution and switchgear system of one building at the school (or some other nearby building), and draw a schematic to accurately represent this system, identifying all components and locations.
- Examine an operating bus duct system and draw a representative schematic identifying all components and locations.
- Utilizing a circuit analyzer (instrument panel), connect a three-phase motor load. Vary the load (from no load to full load) on the motor (with prony brake) and record data on current, voltage, power, bus, power factor. Plot curves of the variables and calculate efficiency and verify power factor readings by calculations.
- Analyze the electrical supply and controls of a building heating and cooling system. Draw schematic and identify all components.
- Analyze the electrical supply and controls of a building lighting and receptacles. Draw schematic and identify all components.

- Hook up single-phase transformer, connect load, record input and output current, voltage, and power. Calculate step-down ratio and transformer losses and efficiency.
- Hook up three-phase transformer, connect load, record input and output current, voltage, and power. Calculate step-down ratio and transformer losses and efficiency.
  a. Δ - Δ
  b. Δ - Y
  Vary reactance loads on each phase. Measure voltage, current, power. Sketch phase-angle relationships for each phase.
- Visit a nearby electric generating station. Record generator nameplate data, count the generator field poles, verify frequency by the equation:

$$\text{Speed} = \frac{60\ f}{\text{power of poles}}$$

- In the plant control room, obtain motor indications of generator volts, amps, watts. Calculate the operating power factor of the generator. Record generator excitation current and voltage (dc); compare to nameplate data.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- List and explain the purpose of basic components of electric power transmission systems from generating plant to user.
- List and explain the purpose of basic components and arrangement of industrial electric power distribution system from the generating plant to various substations for manufacturing processes.
- Describe in proper terminology the application of required metering, capacity, and control of electric power distribution systems.
- Draw a schematic (elementary) diagram using proper electrical symbols of an electrical power distribution system as employed in utilities and industry.
- Define terms as synchronizing (paralleling), phase rotation, true power, reactive (VAR) power, power factor correction.
- Describe methods for PF correction on polyphase circuits by capacitor banks and synchronous machines to meet utility standards and increase line-load capacity, actually measuring amps, watts, VARS, and PF.
- Examine the electrical distribution and switchgear system at the school and draw a schematic to accurately represent this system, identifying the major components and locations.
- Examine the electrical distribution and switchgear system of one building at the school (or some other nearby building), and draw a schematic to accurately represent this system, identifying all components and locations.
- Examine an operating bus duct system and draw a representative schematic, identifying all components and locations.
- Utilizing a circuit analyzer (instrument panel), connect a three-phase motor load. Vary the load (from no load to full load) on the motor

(with prony brake) and record data on current, voltage, power, bus, power factor. Plot curves of the variables and calculate efficiency and verify power factor readings by calculations.

- Analyze the electrical supply and controls of a building heating and cooling system. Draw schematic and identify all components.
- Analyze the electrical supply and controls of a building lighting and receptacles. Draw schematic and identify all components.
- Hook up single-phase transformer, connect load, record input and output current, voltage, and power. Calculate step-down ratio and transformer losses and efficiency.
- Hook up three-phase transformer, connect load, record input and output current, voltage, and power. Calculate step-down ratio and transformer losses and efficiency.
  a. Δ - Δ
  b. Δ - Y
  Vary reactance loads on each phase. Measure voltage, current, power. Sketch phase-angle relationships for each phase.
- Visit a nearby electric generating station. Record generator nameplate data, count the generator field poles, verify frequency by the equation:

$$\text{Speed} = \frac{60\ f}{\text{power of poles}}$$

- In the plant control room, obtain motor indications of generator volts, amps, watts. Calculate the operating power factor of the generator. Record generator excitation current and voltage (dc); compare to nameplate data.

SUGGESTED TEXTS

Gebert, Kenneth L., Edwards, Kenneth R. Transformers. Chicago, IL: American Technical Publishers, Inc.

ELECTRONIC DEVICES

COURSE DESCRIPTION

This course is designed to provide the student with a working knowledge of electronic devices. This course will also develop the student's ability to connect and test basic discrete solid-state components as well as basic vacuum tube circuits. Topics include vacuum tube diode and triode, semiconductor devices, zener diodes and other two-terminal devices, bipolar junction transistors, and other active devices and integrated circuits.

COURSE OUTLINE

		Student Contact Hours	
		Class	Laboratory
I.	Vacuum Tube Diode and Triode	3	4
	A. Introduction to Active Devices		
	B. Physical Characteristics		
	C. Diode Characteristics		
	D. Tube Parameters		
	E. Triode Characteristics		
	F. Characteristic Curves		
	G. Load Resistance		
	H. Gain		
	I. Phase Relationships		
	J. Basic Vacuum Tube Amplifiers		
II.	Semiconductor Diodes	5	7
	A. Atomic Theory for Semiconductors		
	B. Silicon, Germanium, and PN Junctions		
	C. Diode Applications		
III.	Zener Diodes and Other Two-Terminal Devices	6	8
	A. Zeners - Basic Circuits		
	B. Schottsky Diodes		
	C. Varactors (Varicaps)		
	D. Photodiode		
	E. Light-Emitting Diodes (LEDs) and IR Emitters		
	F. Liquid Crystal Diodes		
	G. Solar Cells		
	H. Thermistors		
	I. Industrial Devices		
IV.	Bipolar Junction Transistors (BJT) and Other Active Devices	14	12
	A. PNP and NPN Atomic Characteristics		
	B. BJT Operation		
	C. Amplifying Action		
	D. Amplifier Configurations: Common Base (CB), Common Emitters (CE), Common Collector (CC)		

	Student Contact Hours	
	Class	Laboratory
E. Specification Sheets		
F. JFET and MOSFET Characteristics		
G. FET Operation		
H. Amplifying Action		
I. Amplifier Configurations		
J. Specification Sheets		
V. Integrated Circuits	6	8
A. Types of ICs		
B. Application of ICs		
C. Construction of ICs		

STUDENT LABORATORIES

- Construct and test a common cathode amplifier.
- Design, build, and test a clipper and clamper circuit.
- Design, build, and test a half-wave rectifier and full-wave rectifier circuit.
- Design, build, and test a half-wave filtered power supply.
- Design, build, and test a full-wave filtered power supply.
- Construct and test the common base, common emitter, and common collector amplifier.
- Obtain characteristics of the triac, diac, SCR, and zener using the curve tracer.
- Determine output voltage of the solar cell under different load conditions.
- Construct and test common gate, common source, and common drain amplifiers.
- Identify pin configuration, package type, and characteristics of the integrated circuit using the specifications sheet.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Define the following terms:
  - Vacuum tube
  - Semiconductor diode
  - Zener diode
  - Schottsky diode
  - Varactor
  - Photodiode
  - LED
  - LCD
  - Solar cell
  - Thermistor
  - SCR
  - Diac
  - Triac
  - BJT

FET
Integrated circuit

- List and explain applicatons for all of the above devices.
- Analyze the above devices' operation using specification sheets and characteristic curves.
- Construct and test a common cathode amplifier.
- Demonstrate the application of semiconductor diodes by constructing and testing clipper, clamper, half-wave rectifier, and full-wave rectifier circuits.
- List characteristics and applications of the common base, common emitter, and common collector amplifier.
- List characteristics and applications of the common gate, common drain, and common source amplifier.
- List characteristics and applications of the common cathode amplifier.
- List types and applications of integrated circuits.
- Identify pin configurations, package type, and characteristics of the integrated circuit with the specification sheet.
- Construct and test common base, common emitter, and common collector circuits.
- Construct and test common gate, common source, and common drain amplifiers.
- Use a curve tracer to obtain the characteristics of the triac, diac, SCR, and zener.
- Determine output voltage of a solar cell.

RECOMMENDED TEXT

Boylestad, Robert, and Nechelsky, Louis. Electronic Devices and Circuit Theory. Englewood Cliffs, NJ: Prentice-Hall.

ENGINEERING GRAPHICS

COURSE DESCRIPTION

An introductory course to provide the technician with basic skills and techniques used to communicate information and ideas graphically. Topics to include: an introduction to freehand sketching; basic drafting techniques and procedures; schematic drawing; descriptive geometry; and computer graphics.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Technical Sketching	1	6
A. Sketching Lines, Circles, and Arcs		
B. Using the Box Construction Technique		
C. Sketching in Isometric		
D. Sketching in Oblique		
II. Drafting Fundamentals	1	12
A. Use of Instruments		
B. Lettering		
C. Alphabet of Lines		
D. Drawing Reproduction		
E. Scale		
F. Dimensioning and Tolerancing		
G. Geometric Construction Techniques		
III. Orthographic Projection	2	12
A. Third-Angle Projection Drawing		
B. Section Drawing		
IV. Pictorial Drawing	1	6
Drawing Objects in Isometric		
V. Schematic Drawing and Symbols	2	12
A. Drawing Electronic Schematic Diagrams		
B. "Tape Up" of Printed Circuit Board Designs		
C. Drawing Electrical Wiring Diagrams		
D. Piping Diagrams		
E. Flow Diagrams		
VI. Descriptive Geometry	2	12
A. True Length, Slope, and Bearing		
B. Auxiliary Views		
C. Developments		
VII. Computer Graphics	0	2
A. Drawing on CRT		
B. CAD Introduction		

	Student Contact Hours	
	Class	Laboratory
VIII. Overview of Engineering Graphics Drawing in Industry	1	0

STUDENT LABORATORIES

- Make freehand sketches in isometric and oblique.
- Use drafting instruments to make simple drawings involving geometric construction techniques.
- Make drawings of objects in orthographic.
- Make isometric drawings of simple objects.
- Make schematic drawings and "tape ups."
- Find true length, slope, and bearing of lines.
- Draw surfaces in their true size.
- Make developments of objects.
- Display data graphically on CRT.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Make simple freehand sketches that will describe an object or a process in three dimensions.
- Use drafting instruments to make simple engineering drawings.
- Draw and interpret objects in orthographic projection.
- Draw and interpret simple objects in isometric.
- Prepare and interpret schematic drawings.
- Graphically find the true length, slope, and bearing of a line.
- Determine true shapes and sizes of surfaces from alternative views utilizing the line and plan methods of descriptive geometry.
- Make simple development drawings of objects.
- Use a microcomputer to display data graphically.

RECOMMENDED TEXT

Luzadder, Warren J. Fundamentals of Engineering Drawing. Englewood Cliffs, NJ: Prentice-Hall, 1981.

ENGLISH AND COMPOSITION

COURSE DESCRIPTION

This course is designed to enhance the student's skill in writing, reading, and listening. Topics for student exercises may be chosen from material discussed or experienced in technical courses. Course material will serve to integrate basic communication skills with studies in technical subject areas. Topics to be covered include grammar, writing skills, reading skills, and listening skills.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Communications and the Technician	2	0
A. Why The Technician Must be Proficient in the Art of Communications		
B. Importance of Written Communications as an Essential Skill		
II. Written Expression (Emphasis on Student Writing)	42	0
A. Diction		
B. Sentence Structure		
1. Review of basic parts of speech		
2. Complete sentences		
3. Use and placement of modifiers, phrases, and clauses		
4. Sentence conciseness		
5. Exercises in sentence structure		
C. Grammar Usage		
1. Capitalization		
2. Punctuation		
3. Subject-verb agreement		
D. Paragraph Construction		
1. Topic sentence		
2. Development		
3. Unity and coherence		
4. Transitional devices		
E. Narration, Description, and Exposition		
F. Letter Writing		
1. Business letters		
2. Personal letters		
G. Technical Writing		
III. Improving Reading Skills	5	0
A. Improvement of Reading Habits		
1. Light sources and intensity		
2. Developing proper eye-span and movement		

	Student Contact Hours	
	Class	Laboratory
3. Developing speed and comprehension 4. Scanning, skimming, and surveying B. Understanding Words Through Context Clues		
IV. Improving Listening Skills A. Conversational Courtesies B. Listening Faults C. Following Directions D. Taking Notes	3	0

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Explain the need for effective written communication and an appreciation for the writing process.
- Use commonly misused words correctly in basic sentences.
- Punctuate, capitalize, and spell correctly.
- Recognize and write simple, complex, compound, and complex-compound sentence structures.
- Rewrite ambiguous, wordy statements into clear, terse sentences.
- Recognize and write paragraphs using varied organizational techniques (cause and effect, description, definition, and so on).
- Write paragraphs containing well-defined topic sentences and develop each paragraph into a unified whole.
- Use transitional words and paragraphs to achieve coherency and unity in writing.
- Organize thoughts during the pre-writing stage using a written outline.
- Effectively write a unified, well-developed paper following standard English grammar usage.
- Identify and write acceptable letters in block, modified block, or full block.
- Use efficient reading techniques.
- Use proper techniques for listening and interpreting oral communications.

RECOMMENDED TEXT

Hodges, John C., Whiten, Mary E. Harbrace College Handbook. 8th ed. New York: Harcourt, Brace, Jovanovich, 1977.

Watkins, Floyd C. and Martin, Edwin T. Practical English Handbook. Boston: Houghton Mifflin.

FLUID POWER

COURSE DESCRIPTION

Fluid Power is designed to give the student an overview of fluid power technology and a working knowledge of each of the components used in fluid power circuits. Hydraulic and pneumatic systems will be discussed. Topics presented will include fundamentals of fluid dynamics, conventional fluid circuits and fluid power components.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Introduction and Fundamentals of Fluid Power	3	3
A. Introduction to Fluid Power		
1. Background and applications of fluid power		
2. Advantages and disadvantages of fluid power		
3. Capabilities		
4. How fluid power works		
B. Basic Fluid Power Systems		
1. Hydraulic systems		
2. Pneumatic systems		
C. Review of Physics Fundamentals		
1. Forms of energy		
2. Force and pressure		
3. Work done by a fluid		
4. Power in fluid power systems		
D. Basic Principles of Fluid Behavior		
1. The continuity equation		
2. Bernoulli's theorem		
3. Torricelli's theorem		
4. Gas laws		
E. Basic Fluid Symbols		
1. Hydraulic circuit		
2. Pneumatic circuit		
F. Summary		
II. Fluid Power Properties and Characteristics	3	3
A. Properties of Hydraulic Fluids		
1. Viscosity		
2. Viscosity index		
3. Lubricating ability		
4. Rust and corrosion prevention		
5. Oxidation stability		
6. Resistance to foaming		
7. Flash and fire points		
B. Types of Hydraulic Fluids		
1. Water		

	Student Contact Hours	
	Class	Laboratory
2. Petroleum oils		
3. Water-oil emulsions		
4. Water-glycol fluids		
5. Synthetic fluids		
C. Replacing Hydraulic Oil		
D. Properties of Pneumatic Fluids		
E. Summary		
III. Fluid Storage, Conditioning, and Maintenance	4	4
A. Reservoirs and Tanks		
1. Hydraulic reservoirs		
2. Pneumatic tanks		
B. Temperature Control		
1. Cooling in hydraulic systems		
2. Cooling in pneumatic systems		
C. Filters and Strainers		
1. Types of hydraulic filters		
2. Location of hydraulic filters		
3. Pneumatic filters		
4. Air pressure regulators		
5. Air-line lubricators		
6. FRL units		
D. Sealing Devices		
1. Compression packings		
2. O-rings		
3. V-rings		
4. Piston cup packings		
5. Piston rings		
6. Water rings		
7. Seal materials		
E. Summary		
IV. Pumps and Compressors	4	4
A. Theory of Pumps		
1. Positive-displacement pumps		
2. Characteristics of positive-displacement liquid pumps		
3. Nonpositive-displacement pumps		
B. Hydraulic Pumps		
1. Vane pumps		
2. Piston pumps		
3. Selection of hydraulic pumps		
4. Pump maintenance		
C. Pressure Boosters		
D. Air Compressors		
1. Reciprocating compressors		
2. Rotary compressors		
3. Compressor maintenance		

	Student Contact Hours	
	Class	Laboratory
E. Vacuum Pumps		
F. Summary		
V. Actuators and Fluid Motors	4	4
A. Fluid Power Actuators		
1. Construction of hydraulic cylinders		
2. Cylinder operating characteristics		
3. Construction of air cylinders		
4. Mounting and application of cylinders		
5. Special cylinder types		
6. Rotary actuators		
7. Causes of cylinder failure		
8. Cylinder maintenance		
B. Fluid Motors		
1. Hydraulic motor types		
2. Hydraulic motor performance		
3. Air motors		
C. Summary		
VI. Fluid Distribution and Control Devices	4	4
A. Accumulators		
1. Accumulator types		
2. Accumulator applications		
B. Pressure Intensifiers		
C. Fluid Conductors and Connectors		
1. Rigid pipes		
2. Semirigid tubing		
3. Flexible hoses		
4. Plastic tubing		
D. Fluid Control Devices		
1. Directional control valves		
2. Servo valves		
3. Pressure control valves		
4. Flow control valves		
5. Other control valves		
E. Summary		
VII. Fluid Circuits	4	4
A. Fluid Power Symbols		
B. Basic Hydraulic Circuits		
1. Cylinder circuits		
2. Motor circuits		
3. Speed control		
C. Basic Pneumatic Circuits		
1. Cylinder circuits		
2. Motor circuits		
3. Speed control		
4. Multi-pressure circuits		
D. Synchronous Motion		
1. Hydraulic cylinders in series		
2. Fluid motors as synchronizers		
3. Air cylinders		

4. Hydraulic motors

E. Actuator Speed
   1. Pneumatic circuits
   2. Hydraulic circuits

STUDENT LABORATORIES

I. Construct and operate fluid circuits for single-acting hydraulic, and double-acting cylinders. Compare characteristics and operation of the cylinders.

II. Measure volumetric efficiency of a hydraulic pump, overall efficiency of a hydraulic power system, and delivery rate of an air compressor.

III. Construct and operate fluid power circuits for operation of single-acting, hydraulic and double-acting cylinders, and for operation of hydraulic and pneumatic motors.

V. Measure volumetric efficiency of a hydraulic pump, overall efficiency of a hydraulic power system, and delivery rate of an air compressor.

VI. Construct and operate a circuit using an accumulator to power a pressure intensifier and a circuit to sequence the operation of hydraulic cylinders.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

I. Introduction and Fundamentals of Fluid Power
- Identify components and describe the function of basic hydraulic and pneumatic power systems; show all connections for operating single-acting cylinder.
- Calculate quantities for a fluid power system.
- Construct and operate fluid circuits for single-acting cylinder.
- Describe principles of fluid behavior and explain how they relate to fluid power systems.

II. Fluid Power Properties and Characteristics
- Explain hydraulic system problems (rust, corrosion, oil viscosity too high or low, oil oxidation).
- Describe and list characteristics of hydraulic fluids.
- Construct fluid power circuits, comparing characteristics and operation of each.

III. Fluid Storage, Conditioning, and Maintenance
- List characteristics and function of each major part of a hydraulic reservoir.
- Explain the role of a compressed-air tank in fluid conditioning in a pneumatic system.
- Explain importance and methods of controlling temperature of fluid in hydraulic and pneumatic systems.
- Explain operation, advantages, and disadvantages of various hydraulic filters and filter locations.
- Explain operation of each element in a pneumatic filter-regulator-lubricator unit.

- Draw diagrams of, and list applications and characteristics of various seals.
- List characteristics, applications, and approximate operating temperature ranges of various seal materials.

IV. Pumps and Compressors
- Draw diagrams and explain operating characteristics and applications of various types of pumps.
- Calculate delivery rate of a compressor.
- Explain importance of cooling and how cooling is accomplished with air and water in a multistage piston compressor.
- Explain operation of reciprocating compressors and of positive-displacement and nonpositive-displacement rotary air compressors.
- Explain types of damage and maintenance to prevent these damages to pump and hydraulic compressors.
- Measure volumetric efficiency of a hydraulic pump, overall efficiency of a hydraulic power system, and delivery rate of an air compressor.

V. Actuators and Fluid Motors
- Contrast differences in the construction components and functioning capabilities of hydraulic versus pneumatic cylinders.
- Sketch diagrams and explain operation of common types of fluid actuators.
- Describe common causes for actuator failure and malfunction.
- List procedures for troubleshooting damaged cylnders.
- Compare operating characteristics of basic hydraulic motors (gear, vane, axial piston, radial piston).
- Construct fluid circuits for operation of hydraulic and pneumatic motors and compare operating characteristics.

VI. Fluid Distribution and Control Devices
- List and describe the functioning of basic types of accumulators.
- Explain the importance of common types of conductors and their applications.
- List common types of control valves, their importance, and their operating characteristics.
- Construct and operate a circuit using an accumulator to power a pressure intensifier and a circuit for sequencing the operating of hydraulic cylinders.

VII. Fluid Circuits
- Explain the operation of basic pneumatic and hydraulic circuits and identify circuit components.
- Explain design demands and control characteristics important in construction of fluid circuits, including actuator speed limits, flow control characteristics, synchronous motion, cylinder speed.

SUGGESTED TEXTS

Fluid Power Systems. Waco, TX: Center for Occupational Research and Development, 1980.

FL-01 Introduction and Fundamentals of Fluid Power
FL-02 Fluid Power Properties and Characteristics
FL-03 Fluid Storage, Conditioning, and Maintenance

FL-04 Pumps and Compressors
FL-05 Actuators and Fluid Motors
FL-06 Fluid Distribution and Control Devices
FL-07 Fluid Circuits

Sullivan, James A. Fluid Power Theory and Application. Reston Publishing Company, Inc., 1982.

Vickers. Mobil Hydraulics Manual.

FUNDAMENTALS OF ELECTRICITY AND ELECTRONICS (DC - AC)

COURSE DESCRIPTION

This course provides the student with the knowledge and skills to analyze basic dc and ac circuits. The course includes the following main topics: basics of electricity, dc circuits, capacitance and capacitive circuits, magnetism and magnetic circuits, inductance and inductive circuits, alternating current and phasors, reactance and impedance, and ac circuits and power.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Basics of Electricity A. Molecular Structure B. Current and Voltage C. Voltage Sources D. Resistance E. Work and Power	3	4
II. DC Circuits A. Series and Parallel Circuits B. Series-Parallel Circuits	6	8
III. Capacitance and Capacitive Circuits A. Capacitance B. Capacitance in DC Circuits	3	4
IV. Magnetism and Magnetic Circuits A. Magnetism B. Magnetic Circuits	3	4
V. Inductance and Inductive Circuits A. Inductance B. Inductive Circuits	3	4
VI. Alternating Current and Phasors A. Alternating Current B. Phasors C. Electrical Measurements	6	4
VII. Reactance and Impedance A. Reactance B. Impedance	3	6
VIII. AC Circuits and Power	3	6

STUDENT LABORATORIES

I. Basic Electricity
- Calculate and measure current, voltage and resistance in a basic dc circuit.

II. DC Circuits
- Measure electrical parameters in live circuits observing safety precautions and proper procedures in the use of test equipment.
- Calculate and measure E, I, R in a series-parallel circuit.

III. Capacitance and Capacitive Circuits
- Calculate and measure transient characteristics of RC circuits.

IV. Magnetism and Magnetic Circuits
- Construct a simple transformer and measure voltage and current in primary and secondary.

V. Inductance and Inductive Circuits
- Calculate and measure transient characteristics of RL circuits.

VI. Alternating Current and Phasors
- Calculate and measure frequency, period, and wavelength of a waveform.
- Calculate and measure peak, average, and effective values of a sine wave.

VII. Reactance and Impedance
- Measure and calculate electrical parameters of a circuit containing: resistors, capacitors, and inductors.

VIII. AC Circuits and Power
- Calculate and measure the power factor of an RLC circuit.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

I. Basics of Electricity
- Define voltage, current, resistance.
- Calculate current, voltage or resistance given any two of these.
- Define relationships between E, I, R, P.

II. DC Circuits
- List correct procedures for connecting electrical equipment and test equipment to measure electrical parameters in live circuits.
- Identify precautions to be taken when working with live circuits to protect the individual and others from electrical shocks.
- Calculate voltage, current, and resistance in a series circuit.
- Calculate voltage, current, and resistance in a parallel circuit.
- Calculate voltage, current, and resistance in a series-parallel circuit.

III. Capacitance and Capacitor Circuits
- Calculate capacitance in Farads given necessary dimensional and material characteristics.
- Calculate total capacitance of series and parallel capacitors.
- Calculate charge and discharge waveforms of an RC circuit.

IV. Magnetism and Magnetic Circuits
- Calculate and describe the interaction between magnetic fields and direct current, units of measure, and basic applications.

V. Inductance and Inductive Circuits
- Calculate the inductance in henries given necessary dimensional and material characteristics.
- Calculate the total inductance of series and parallel inductance.
- Calculate charge and discharge waveforms of an RL circuit.

VI. Alternating Currents and Phasors
- Calculate peak, average, and effective values of a sine wave.
- Calculate frequency, period, and wavelength of a waveform.
- Calculate the phasor value for selected voltage and current waveforms.
- Demonstrate proper application of laboratory test equipment in the analysis of basic electrical circuits.

VII. Reactance and Impedance
- Calculate the impedance of circuits containing: resistors, capacitors, and inductors.

VIII. AC Circuits and Power
- Calculate and measure nonresonant characteristics of both series and parallel RLC circuits.
- Calculate and measure circuit phase angle and power factor.

RECOMMENDED TEXT

Boylestad, Robert D. Introductory Circuit Analysis. 4th ed. Merrill Publishing Co.

Jackson, Herbert W. Introduction to Electric Circuits. 5th Ed. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Fundamentals of Energy Technology. Waco, TX: Center for Occupational Research and Development, 1980.

EF-01 Energy Technology
EF-02 Sources of Energy: I
EF-03 Sources of Energy: II
EF-04 Uses of Energy
EF-05 Energy Analysis
EF-06 Energy and the Environment
EF-07 Energy Resource Guide

FUNDAMENTALS OF ENGINEERING TECHNOLOGY

COURSE DESCRIPTION

This course introduces and prepares the student for the broad, changing field of engineering technology. Each of the three areas (electronic, electromechanical, and mechanical) taught in the engineering technology curricula is investigated according to content, jobs, equipment used, and career advancement. Laboratory projects emphasize "hands-on" experiences with devices, processes, and systems of the technology. A significant emphasis is placed on developing basic technician skills in areas such as formula interpretation, dimensional analysis, systems of units, use of a calculator, graphing data, preparing a laboratory notebook, and recognizing safety hazards.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. An Overview of Engineering Technology	2	4
A. Introduction to Engineering Technology		
B. Productivity and Technology		
C. Role of the Engineering Technician		
D. Effects of Technology on International Economics		
E. Impact of Technological Change		
1. Information and data processing		
2. Production processes		
3. Communications		
4. Life and leisure		
5. Transportation		
II. Basic Technician Skills	7	22
A. Solving Problems		
1. Formula interpretation		
2. Dimensional analysis		
3. International system of units		
4. Use of a scientific calculator		
5. Estimating the correct answer		
B. Communicating Technical Information		
1. Precision and accuracy		
2. Graphs and data tables		
3. Engineering laboratory notebooks		
4. Reading and drawing schematics and blueprints		
5. Written and oral communications		
C. Safety		
1. Recognizing safety hazards		
2. First response to medical emergencies		

	Student Contact Hours	
	Class	Laboratory
III. Survey of Electromechanical Engineering Technologies A. Description of the Technological Field B. Common Equipment and Processes C. Typical Job Titles and Work Settings D. Career Opportunities E. Innovations and Trends F. Fundamental Courses	2	4
IV. Survey of Electronic Engineering Technologies A. Description of the Technological Field B. Common Equipment and Processes C. Typical Job Titles and Work Settings D. Career Opportunities E. Innovations and Trends F. Fundamental Courses	2	4
V. Survey of Mechanical Engineering Technologies A. Description of the Technological Field B. Common Equipment and Processes C. Typical Job Titles and Work Setting D. Career Opportunities E. Innovations and Trends F. Fundamental Courses	2	4
VI. The Systems Approach to Engineering Technologies A. The General Systems Approach 1. Definition and overview 2. Characteristics of systems 3. Types of systems 4. Systems models 5. Uses of systems theory B. Elements of Systems in Engineering Technology 1. Electromechanical technology 2. Electronic technology 3. Mechanical technology C. Interrelations of Fundamental Courses and Technical Systems 1. Math relationships 2. Physics relationships	2	4
VII. Career Advancement A. Tasks Performed by Technicians B. Skills Needed for Advancement C. Training Programs for Career Advancement D. The Future of Engineering Technology E. Professional Development Opportunities F. Career Decision Making G. Attitude and Advancement	2	2

71

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Interpret formulas and use dimensional analyses to solve analytical problems.
- Use a scientific calculator to solve mathematical problems.
- Estimate the correct answer to problems by mathematical approximations and by logical deduction.
- Express measured technical data with the appropriate precision and accuracy.
- Prepare graphs of measured experimental data.
- Discuss differences and the commonalities of electronics, electromechanical, and mechanical technologies in the modern industrial world.
- Use the systems approach to solve a simple conceptual problem.
- Describe the meaning of "system" in engineering technology.
- Discuss the future and potential of the engineering technology profession.
- List and describe important considerations for career growth and advancement in the engineering technology profession.
- Recognize mechanical, electrical, thermal, and fluid systems found in basic technical devices.
- Use appropriate SI units.
- Prepare and maintain a correctly formatted engineering laboratory notebook.
- Identify potential safety hazards in student laboratories.
- Describe at least six types of medical emergencies and the appropriate first response to them.

RECOMMENDED TEXT

Fundamentals of Engineering Technology. Georgia Department of Education and Center for Occupational Research and Development, 1982.

The following instructional modules, from Center for Occupational Research and Development, Waco, TX.

S-1 Formula Interpretation
S-2 Dimensional Analysis
S-3 International Systems of Units
S-8 Precision, Accuracy and Measurement
S-6 Reading and Drawing Graphs
S-9 Engineering Laboratory Notebook
SH-09 Recognizing Job Safety Hazards
SH-04 First Response to Medical Emergencies

MANUFACTURING PROCESSES I

COURSE DESCRIPTION

This course is designed to provide a background of knowledge covering various manufacturing materials and fundamental types of manufacturing methods as employed in cold working processes. Through lecture, demonstration, and practical applications the student is given the opportunity to become familiar with various types of machine tools, tooling, measuring, and inspection procedures. Automation is introduced and information is presented to acquaint the student with the practices of numerical control for machine tools and the uses of special machines.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Introduction to Production Processes	3	4
A. Course Objectives		
B. Production Design and Process Selection		
1. Product specifications		
2. Production design		
3. Production process		
4. Inspection		
5. Marketing		
II. Principles of Metal Cutting	3	4
A. Mechanics of Metal Cutting		
B. Metal Cutting Tools		
III. Metal Cutting Tools	12	16
A. Turning Lathes		
1. Types		
2. Construction and design		
3. Operation		
B. Turret and Automatic Lathes		
1. Types		
2. Construction and design		
3. Operations		
4. Multiple tooling		
C. Screw Machines		
1. Types		
2. Construction and design		
3. Operations		
D. Drilling Machines		
1. Types		
2. Construction and design		
3. Operations		
E. Boring Machines		
1. Types		
2. Construction and design		
3. Operation		

	Student Contact Hours	
	Class	Laboratory
F. Planers and Shapers		
1. Types		
2. Construction and design		
3. Operation		
G. Milling Machines		
1. Types		
2. Construction and design		
3. Operation		
H. Broaching Machines		
1. Types		
2. Construction and design		
3. Operation		
I. Sawing Machines		
1. Types		
2. Construction and design		
3. Operation		
J. Grinding Machines		
1. Types		
2. Construction and design		
3. Operation		
K. Gear Cutter Machines		
1. Types.		
2. Construction and design		
3. Operations		
IV. Special Cutting Tools	6	4
A. Chemical Milling Machines		
1. Processes		
2. Applications		
3. Operation		
B. Electrical Discharge Machines		
1. Processes		
2. Applications		
3. Operation		
C. Electrochemical Machines		
1. Processes		
2. Applications		
3. Operation		
D. Laser Beam Machines		
1. Processes		
2. Applications		
3. Operation		
E. Ultrasonic Machines		
1. Processes		
2. Applications		
3. Operation		

	Student Contact Hours	
	Class	Laboratory
F. Electron Beam Machines		
1. Processes		
2. Applications		
3. Operation		
G. Automatic Machines		
1. Definition		
2. Application		
H. Numerical Control Machines		
1. Definition		
2. Computers		
3. Control concepts		
4. Application		
5. Operation		
V. Metal Forming Machines	6	0
A. Processes		
B. Operations		
1. Stamping		
2. Piercing		
3. Bending		
4. Drawing		
5. Rolling		
6. Squeezing		
VI. Measuring, Gaging, and Inspection Techniques	6	4
A. Visual Inspection		
B. Direct Measurement		
C. Comparative Measurement		
D. Precision Measurement		
E. Measuring Standards		
F. Tolerances		
G. Optical Measuring		
VII. Finishing	3	0
A. Surface Finishing		
1. Types		
2. Processes		
B. Cleaning and Coating		
1. Mechanical cleaning		
2. Chemical cleaning		
3. Organic coating		
4. Inorganic coating		
5. Metallic coating		
6. Conversion coating		

STUDENT LABORATORIES

I. Introduction to Production Processes
- Conduct a tour of the school facilities to include machine shop, tool and die shop and welding shop.

II. Principles of Metal Cutting
- Conduct tour of local manufacturing industry which would include machine shops, foundries, fabrication shops, etc.

- Observe machine operations in local industries.
- Show film of different forms of metal cutting procedures.
- Given a hypothetical piece part, have the student design and describe a manufacturing process to produce it, to include the overall system, necessary equipment, and processes performed.

III. Metal Cutting Tools (Two or more labs)
- Have student assist in performing proper metal cutting procedures on selected piece parts on the following metal cutting tools:
  - Lathe
  - Milling machine
  - Drill press
  - Planer and shaper
  - Saw
  - Grinder

IV. Special Cutting Tools
- Show a film on as many processes as possible.
- On the CNC milling machine, take a simple piece part, develop a program to cut two holes, program the machine and run the part.

V. Metal Forming Machines
- None.

VI. Measuring, Gaging, and Inspection Techniques
- Instructor will demonstrate common measuring devices to class. Student then will practice measurements with each of the devices, and will report results.
- Given selected machined parts, student will select the proper measuring device, perform and report measurements for each.

VII. Finishing.
- None.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

I. Introduction to Production Processes
- Discuss elements used in selection and design of the processes used in manufacturing.

II. Principles of Metal Cutting
- Describe what takes place when metal is cut.
- Name and describe principal cutting tools.
- Explain the purpose of cutting fluids.

III. Metal Cutting Tools
- Define the terms "speed" and "feed" and explain how they are related to lathe work.
- Define the following lathe terms:
  - Plane or straight turning
  - Facing
  - Parting
  - Chamfering
  - Knurling

Swing
Headstock
Tailstock
Coinage
Bed

- Explain operation of an engine lathe.
- Describe the most common lathe accessories and attachments.
- List ways to cut tapers on a lathe.
- Contrast major differences among a bench lathe, a tool lathe, and a speed lathe.
- Discuss important features of a horizontal turret lathe and describe the nature of work performed.
- Explain reasons for using a screw machine.
- Define the following terms:

  Drilling
  Core drilling
  Counterdrilling
  Step drilling
  Boring
  Counterboring
  Spot-facing
  Countersinking
  Reaming

- Name the two types of boring machines.
- Contrast important similarities and differences between shaping and planing.
- Describe the difference between peripheral milling and face milling.
- Describe a hole broach and name its principal elements.
- List important advantages of power sawing.
- Give a practical tolerance for production grinding operations.
- Name the three classes of gear cutting methods.

IV. Special Cutting Tools

- Prepare a brief outline showing the sequence of operations involved in:

  Chemical blanking
  Contour machining

- Explain why EDM is not classified as a high-volume production process.
- Compare similarities and differences of ECM and EDM.
- Discuss reasons that a CO_2 laser is particularly effective for machining nonmetals.
- List important factors that control the quality of surface finish obtained by ultrasonic machines.
- Define an electron beam.
- Given certain production criteria, make an analysis to determine whether to automate an operation.
- Prepare a sketch illustrating how five axes of machine motion might be applied to manufacturing operations on a machine part.
- Set up and run a simple cutting task on a CNC milling machine.

V. Metal Forming Machines

- List five products that are examples of the forming process.
- Define the following forming operations:

  Stamping
  Piercing

Bending
Drawing
Rolling
Squeezing

- Give an example of the machines and tools used for those operations listed above.

VI. Measuring, Gaging, and Inspection Techniques

- Explain differences between inspection, quality control, and statistical quality control.
- Define the following measurement terms:
  Tolerance
  Allowance
  Clearance
  Basic size
  Standard size
  Nominal size
- Given a number of direct measurement, comparative measurement, and precision measurement instruments, perform and record results of an inspection of various parts to determine if the parts conform to appropriate measuring standards.

VII. Finishing

- Using a table of typical surface finish values, compare the ranges of surface-roughness-height values of drilling, grinding, and polishing.
- Explain why honing cannot be used as a method to improve errors of hole location or alignment on a workpiece.
- List some limitations of abrasive blasting.
- Discuss the major advantages of ultrasonic cleaning.
- Explain why alkaline cleaning of aluminum, zinc, brass, or tin workpieces is not recommended.
- Explain the function of organic coating and inorganic coating.
- Compare metallic coating with conversion coating.

SUGGESTED TEXTS

Doyle, L.E. Manufacturing Processes and Materials for Engineers. 2nd ed. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1969.

Yankee, H.W. Manufacturing Processes. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1979.

MECHANICAL DEVICES AND SYSTEMS

COURSE DESCRIPTION

Mechanical Devices and Systems is an in-depth study of principles, concepts, and applications of various mechanisms that may be encountered in industrial applications of engineering technology. The mechanical components and systems are divided into eight units of instruction, covering operational principles, uses, maintenance, troubleshooting, and repair and replacement procedures. The procedure or application portion of the units will emphasize practical maintenance and installation of equipment and selection and specification of proper replacement components from manufacturers' catalogs.

Units of instruction will cover belt drives, chain drives, drive train components, linkages, fans and blowers, and valves.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Belt Drives	3	9
A. Mechanical Drives		
B. The Belt Drive		
C. Types of Belts		
D. Flat Belts		
1. Length measurement and calculation		
2. Belt-speed calculation		
3. The positive-drive belt		
E. Maintenance of flat belts		
1. Splicing of flat belts		
2. Troubleshooting of flat belts		
F. V-Belts		
1. Design variations		
2. Variable-speed belt drives		
3. Forms of belt drives		
4. V-Belt sizes and matching numbers		
5. Pulley size		
G. Maintenance of V-Belt Drives		
1. Sheave alignment in V-belt drives		
2. V-belt installation		
3. Belt tension		
4. Troubleshooting of V-belts		
5. V-belt drive selection		
II. Chain Drives	2	6
A. Characteristics of Chain Drives		
B. Types of Chains		
C. Chain Length		
D. Sprockets		
1. Types of sprockets		
2. Sprocket speed		

	Student Contact Hours	
	Class	Laboratory
3. Sprocket position		
4. Idler sprockets		
5. Selection of chain drives		
E. Maintenance		
1. Alignment		
2. Chain installation		
3. Chain tension and sag		
4. Lubrication		
5. Sprocket inspection		
F. Troubleshooting of Chain Belts		
G. Chain Storage		
III. Gear Drives	4	12
A. Mechanical Basics		
B. Gear Basics		
C. Terminology		
D. Types of Gears		
1. Parallel-axes gears		
2. Intersecting-axes gears		
3. Nonintersecting, nonparallel-axes gears		
4. Moving-axes gears		
E. Gear Trains		
F. Maintenance		
1. Lubrication		
2. Adjustment		
3. Inspection and troubleshooting		
G. Selection of gear drives		
IV. Drive Train Components I.	3	9
A. Shafts		
1. Shaft spacing		
2. Bossed and turned-down shafting		
3. Flexible shafts		
4. Shaft expansion		
5. Alignment		
6. Metalizing of shafts		
7. Bent shafts		
8. Shaft selection		
9. Shaft keys and keyseats		
B. Bearings		
C. Plain Bearings		
1. Mounted plain bearings		
2. Lubrication		
D. Antifriction Bearings		
1. Radial bearings		
2. Thrust bearings		
3. Combination bearings		
4. Mounted bearings		
5. Shaft alignment		
6. Bel[illegible]ension		
7. Sho[illegible] loads		

80

	Student Contact Hours	
	Class	Laboratory
8. Bearing installation		
9. Vibration		
10. Current through bearings		
11. Lubricants Lubrication systems		
12. Troubleshooting		
13. Selection of antifriction bearings		
V. Drive Train Components II	2	6
A. Seals		
1. Static Seals - gaskets and O-rings		
2. Dynamic seals		
3. Mechanical seals		
B. Couplings		
1. Definitions		
2. Rigid couplings		
3. Flexible couplings		
4. Universal joints		
5. Selection of couplings		
C. Clutches		
1. Definitions		
2. Friction clutches		
3. Magnetic clutches		
4. Jaw clutches		
5. Dry fluid clutches		
6. Hydraulic clutches		
VI. Linkages	2	6
A. Terms and Definitions		
B. Types of Linkages		
C. Cams		
1. Terms and definitions		
2. Types of cams		
3. Types of followers		
VII. Fans and Blowers	2	6
A. The Two Fan and Blower Types		
1. Axial-flow fans and blowers		
2. Centrifugal fans and blowers		
3. Materials of construction		
4. Accessories		
B. Testing and Air Flow Measurements		
C. Anemometers		
D. Maintenance		
E. Fan Selection		
F. General Information and Terms		
1. Pressure increases		
2. Fan laws		
3. Fan wheel diameter		
4. Pressure and pressure difference		
5. Air horsepower		

	Student Contact Hours	
	Class	Laboratory
6. Air density		
7. Efficiency		
VIII. Valves	2	6
A. Components and Operation Principles		
B. Uses of Valves		
C. Valve Types		
D. Materials for Valves		
E. Valve Codes and Markings		
F. Valve Actuators		
G. When Automatic Controllers are Used		
H. Valve Maintenance		

STUDENT LABORATORIES

I. Identify and correct defects in operating motor and belt drive system.

II. Identify and correct defects in operating motor and chain drive system.

III. For a geared transmission with each gear numbered, disassemble, label each gear as to type, inspect each for visible wear, and label power flow from input to output shaft.

IV. Disassemble drive chain assembly, identify bearings removed, clean and inspect for damage, lubricate properly, and reassemble.

V. Disassemble a sealed system such as a hydraulic pump; identify type of seal, couplings, clutches; clean, inspect and replace as necessary; and reassemble system.

VI. Upon examination of two or more of various list of machines, identify types of linkages and cams used. Sketch and describe each mechanism's movement using arrows to show force input and output.

VII. Set up fan/(round) air duct systems; measure air pressure at five concentric locations in the duct, power consumption of fan, and using this data calculate efficiency rating, volume flow rate, and fan horsepower.

VIII. Disassemble, sketch and identify parts; reassemble, relubricating and repacking during reassembly as necessary, each of the various valves.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

I. Belt Drives
- Cite applications, advantages, disadvantages, and design characteristics of various types of belts.
- Calculate belt length, belt velocity, and pulley diameter.
- Properly install and tension a belt.
- Describe ways improperly maintained belts can lose energy.
- Identify and cite possible causes of defects in belts and belt systems.

II. Chain Drives
- Identify various types of chains, including applications, parts labeling, and maintenance.
- Calculate chain length and slack and sprocket speed.
- Describe how alterations in size, number of teeth, and speed affect energy balance and life of a chain-drive system.
- Explain alignment and adjustments for chain drives.
- Install and properly adjust a chain.

III. Gear Drives
- Use applicable formulas to calculate quantities for a gear-drive system.
- Identify various gear types, including their uses, distinguishing characteristics, advantages, and disadvantages.
- Describe various gear trains; cite distinguishing characteristics, and applications.
- Given a geared transmission, disassemble, label each gear as to type, inspect and detect visible wear, and label power flow from input to output shaft.

IV. Drive Train Components I
- Explain the function of shafts and keyways.
- Identify and explain the use of common plain bearings.
- Discuss effects of friction in the use of plain and antifriction bearings.
- Describe the function of bearings in relation to shafts, and discuss their maintenance and operating characteristics.

V. Drive Train Components II
- Select and appropriately utilize proper gaskets for a given drive train.
- Explain the use of seals, couplings, and packing in drive trains.
- Explain uses and operating characteristics of common clutches in drive systems.

VI. Linkages
- Name, and explain the operational characteristics and major components of, common mechanical linkages.
- List and describe the uses and operational characteristics of common cams and cam systems.

VII. Fans and Blowers
- List and describe the operation of common fans and blowers.
- Distinguish between uses of fans and uses of blowers.
- Identify common problems and their solution in the implementation of fan and blower systems.

VIII. Valves
- Identify major components of valves.
- List functions and distinguishing operating characteristics of principle types of valves.
- Select proper valve type for a given set of requirements.
- Identify and describe basic types of actuators.
- Explain procedures for inspecting and maintaining valves.

83

SUGGESTED TEXTS

Mechanical Devices and Systems. Waco, TX: Center for Occupational Research and Development, 1980.

MS-01 Belt Drives
MS-02 Chain Drives
MS-03 Gear Drives
MS-04 Drive Train Components I
MS-05 Drive Train Components II
MS-06 Linkages
MS-07 Fans and Blowers
MS-08 Valves

Millwright and Mechanics Guide. Audel.

Machinery Handbook.

REFERENCES

Mechanical Maintenance Series. Technical Publishing Co.

Manufacturer's catalogs for all types of devices covered in the outline.

MECHANICAL DRIVES

COURSE DESCRIPTION

Mechanical Drives combines the elements of mechanical theory with those of practicality. Topics treated include: various gear drive configurations employing spur, bevel, and helical gears, belt drives of several types, chain drives, friction drives, and some selected special topics such as cams and universal joints. The course is intended for use by students who have had little or no previous exposure to practical applied mechanics. The course deals with practical skills of mechanical assembly and the principles of operation of a variety of mechanisms.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Belt Drives	6	8
A. Types of Belts		
1. Flat belts		
a. Length measurement and calculations		
b. Belt speed calculation		
c. Maintenance of flat belts		
2. Disk drives		
a. Speed calculators		
b. Maintenance of disk drives		
3. Vee belts		
a. Design variations (types)		
b. V-Belt size and matching numbers		
c. Speed calculations		
d. V-belt maintenance		
4. Timing belts		
a. Length measurement & calculation		
b. Speed calculations		
c. Timing belt maintenance		
II. Chain Drives	3	4
A. Types of Chain Drives		
B. Length and Speed Calculations		
C. Maintenance of Chain Drives		
III. Gear Drives	9	12
A. Gear Terminology		
1. Gear diameters		
2. Gear teeth		
3. Displacement ratio		
4. Velocity ratio		
5. Torque ratio		
B. Types of Gears		
1. Helical gears		
2. Bevel gears		

	Student Contact Hours	
	Class	Laboratory
3. Rack and pinion		
4. Worm and wheel		
5. Block and screw		
C. Gear Trains		
1. Simple trains		
2. Compound trains		
3. Reverted gear		
4. Internal gears		
5. Planetary trains		
6. Combined mechanisms		
IV. Other Drive Mechanisms	3	4
A. Spring Mechanisms		
B. Flywheels		
C. Pulley Blocks		
D. Differential Hoists		
E. Rotary Cams		
F. Couplings		
1. Rigid couplings		
2. Flexible couplings		
V. Drive Train Components	9	12
A. Shafts		
B. Bearings		
C. Seals/Gaskets		
D. Clutches		
E. Lubricants		

STUDENT LABORATORIES

I. Belt Drives
- Inspect operating belt-drive system, checking for proper belt tension and pulley alignment. Inspect for all possible defects, listing causes and remedies for each.

II. Chain Drives
- Observe chain-drive system in operation, checking for abnormal wear or breakage. Check chain tension and sprocket alignment for proper operation.

III. Gear Drives
- Using cut-away truck, tractor, or automobile transmission, identify and inspect all gears, determine proper lubricant, and trace power flow from input shaft to output shaft for all forward gears.

IV. Other Drive Mechanisms
- Disassemble, clean, and identify all parts of a drive-train assembly, identifying the purpose for each part.

- On flat tabletop, use wood blocks with weights attached to determine sliding and rolling friction.

V. Drive Train Components
- Inspect a drive transmission system; describe types and major parts of seals, couplings, and clutches.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

I. Belt Drives
- Cite characteristics, applications, advantages, and disadvantages of different types of belts.
- Calculate belt velocity, pulley diameter, and belt tension for most efficient operation.
- By inspection of defective belt systems, diagnose and cite causes of defects.

II. Chain Drives
- Identify types of chains; cite applications and label parts of each type.
- Calculate chain length, sprocket speed, and chain slack for various described systems.
- Align and adjust various chain-drive systems.
- Properly lubricate chain-drive systems for energy efficiency.

III. Gear Drives
- Calculate work, power, horsepower, torque, mechanical advantage, and gear ratio for various gear-drive systems.
- Describe uses, distinguishing characteristics, advantages and disadvantages for various gear drives.

IV. Other Drive Mechanisms
- Identify and describe uses of spring mechanisms, flywheels, pulley blocks, differential hoists, rotary cams, and couplings.

V. Drive Train Components
- Identify and explain characteristics, uses, advantages, and disadvantages of various types of plain and antifriction bearings and their mounts. Describe bearing damage and methods for prevention.
- Identify pulley and coupling location in relation to bearings.
- List and describe gasket seals, joints, and materials, and select the proper gasket for an application.
- Describe O-ring, dynamic, and mechanical seals, listing characteristics and uses for each.
- Describe, sketch, and list design characteristics of different types of rigid and flexible couplings.
- Describe and list design characteristics of various types of clutches.

RECOMMENDED TEXT

Machinery Handbook.

Mark's Engineering Handbook.

Mechanical Devices and Systems. Waco, TX: Center for Occupational Research and Development, 1980.

MS-01 Belt Drives
MS-02 Chain Drives
MS-03 Gear Drives
MS-04 Other Drive Mechanisms
MS-05 Drive Train Components

Mechanical Maintenance Series. Technical Publishing Co.

Millwright and Mechanics Guide. Audel.

PHYSICS I

DESCRIPTION

A practical approach toward the concepts of force, work, rate, momentum, and resistance is presented in Physics I. Students are shown, by classroom demonstration, how these five concepts are applied to the four energy systems - mechanical, fluidal, electrical, and thermal - and then will perform laboratory experiments that relate each concept to the four energy systems.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Force	9	18
A. Mechanical Systems		
1. Linear force		
2. Units of mass and force		
3. Forcelike quantities		
4. Torque		
B. Fluidal Systems		
1. Pressure		
2. Density/pressure relationships		
C. Electrical Systems		
1. Electromotive force (EMF)		
2. Methods of producing an EMF		
D. Thermal Systems		
1. Temperature difference		
2. Temperature scales		
II. Work	7	14.5
A. Mechanical Systems		
1. Mechanical work, translational		
2. Mechanical work, rotational		
B. Fluidal Systems		
1. Pressure/volume relationships		
2. Energy considerations		
C. Electrical Systems		
1. Charge movement and EMF		
2. Conversion factors for electrical systems		
3. Current		
D. Thermal Systems		
1. Heat flow rate		
2. Heat measure		
3. Change of state		
III. Rate	6	12
A. Mechanical Systems		
1. Speed and velocity, linear motion		
2. Acceleration, linear		
3. Rotational motion, angular velocity		

	Student Contact Hours	
	Class	Laboratory
4. Angular acceleration		
B. Fluidal Systems		
1. Volume flow rate		
2. Mass flow rate		
C. Electrical Systems		
1. Current		
2. Ac/dc		
D. Thermal Systems		
1. Heat energy transfer		
2. Heat flow rate		
IV. Momentum	3	6
A. Linear Momentum		
B. Impulse and Momentum Change		
C. Conservation of Momentum		
D. Angular Momentum		
E. Momentum in Fluidal Systems		
V. Resistance	6	12
A. Mechanical Systems		
1. Dry friction		
2. Static and kinetic friction		
B. Fluidal Systems		
1. Fluid resistance in pipes		
2. Viscosity		
C. Electrical Systems		
1. Ohm's law		
2. Resistivity of conductors		
D. Thermal Systems		
1. Thermal resistance		
2. Insulation		

STUDENT LABORATORIES

I. Force

Gravity - Scales and balances are used in determination of the weight and mass of several objects.

Addition of Mechanical Forces - Students will solve a series of force problems with multiple forces acting on a single point through use of a force table and a scale.

Addition of Torques - Students will extend their experience with force problems through an investigation of torques.

Stress and Strain - An introduction to materials strength is accomplished by measurement of Hooke's law values and the ultimate tensile strength of brass, copper, and aluminum wire.

Density, Buoyancy, and Specific Gravity - A hydrometer is used to determine the amount of antifreeze in radiators, the amount of acid in batteries, and so forth.

Manometers - Use of a U-tube manometer for verification of a pressure gage's calibration introduces concepts of pressure measurement.

Electric Forces and Fields - Students will investigate geometry of electric field lines and their relationship to electrode shape with respect to a static electric field.

Magnetic Forces and Fields - The relationship of electric and magnetic fields is investigated through construction and operation of an electromagnet.

Thermometers - The four temperature scales, their conversion equations, various types of thermometers, and calibration of a liquid-in-glass thermometer are investigated.

Temperature Difference and Heat Flow - Heat transmission via conduction, convection, and radiation is investigated through experimental measurements and observations.

II. Work

Work Done on an Elevator - Mechanical work required to lift objects vertically and via an inclined plane is determined by experimental means.

Work Done by a Winch - The concept of work in rotational systems is investigated via experimental measurements and observations with a simple winch.

Work Done by a Water Pump - Efficiency and work accomplished by a water pump are calculated from experimental data obtained through measurement of fluid weight moved, time, current, and voltage.

Heat Energy Required for a Temperature Increase - A calorimeter is employed in determination of some thermal properties of materials.

Fundamentals of Air Conditioning - Student will experience a practical exercise in determining efficiency of actual air conditioning equipment found in his or her daily environment.

III. Rate

Velocity at Constant Acceleration - Applying equations of motion to results with an inclined track and a level track section, student will demonstrate mathematical competency with respect to motion problems.

Displacement at a Constant Acceleration - Using data extracted from experimentation with inclined and level track sections, student will solve any two motion parameters when given the three remaining motion parameters.

Rotational Motion - Using equations and principles of rotational motion, student will determine angular velocity and angular acceleration of a phonograph turntable.

Electric Current - Ac and dc ammeters are employed to make current measurements to acquaint student with operation of these devices.

Frequency - Student will use pendulum, laser, and oscilloscope in the study of frequency in mechanical and electrical systems.

Heating and Cooling Rate - Practical experience is provided in measurement, calculation, and graphical plotting of data extracted from experimental procedures found in this laboratory.

IV. Momentum

Angular Momentum of a Flywheel - Student is provided with a procedure for calculation of angular momentum of a flywheel device and gains exposure to the analogy between translational and rotational quantities.

Impulse and Momentum - Impulse and change in momentum as they apply to mechanical systems of modern technology are investigated.
Gyroscope - Investigations in angular momentum and effects of external forces on a spinning gyroscope are presented, including student construction of a simple gyrocompass.

V. Resistance
Effects of Lubricants - The coefficient of static and kinetic friction is calculated for various situations involving various materials slid on an aluminum plate both with and without lubricants.
Rolling Friction - Effects of rolling friction are compared to sliding and the coefficient of rolling friction is determined in two cases.
Viscosity - Methods for the measure of viscosity and the effect of temperature on viscosity of lubricants are investigated by use of a rolling sphere viscometer and several lubricating oils at varying temperatures.
Fluid Resistance in Pipes - Effects of pipe length and diameter on friction losses are investigated with respect to fluid systems.
Valves and Regulators - Student will gain familiarity with use and care of gas regulators and valves and will perform measurements with respect to resistance of these devices.
Ohm's Law - A volt-ohm-milliammeter, dc power supply, and single resistor circuit will be employed in examination of the interrelationship of voltage, current, and resistance.
Series and Parallel Resistors - Series and parallel circuits of light bulbs are used in investigation of circuit arrangement effects upon electrical current.
Conductors, Semiconductors, and Insulators - Electrical properties classed as conductors, semiconductors, and insulators are investigated.
Resistance of Wires - Effects of length, cross-sectional area, and temperature on the resistance of electrical wires are investigated in two ways.
Resistance of Semiconductor Junctions - Student will measure resistances of several diodes and transistors through use of a milliammeter, microamp meter, and voltmeter.
Volt-Ohm-Milliammeter - Additional investigations into Ohm's Law are pursued while the student is exposed to proper methods of operation of the VOM and how this instrument functions.
Thermal Conductivity - Effects of thermal conductivity and thickness of material on heat flow are investigated through use of a hot plate and heat lamps in conjunction with oven thermometers.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

I. Force
- Define the following physical quantities and, where applicable, state their units in both SI (International System of Units) and English System of Units:
  Force

Torque
Pressure
Voltage
Temperature difference

- Given two or more mechanical forces acting along the same line, determine the resultant force.
- Given two of the following quantities in a mechanical rotational system, determine the third:
  - Force
  - Lever arm
  - Torque
- Given two of the following quantities in a fluid system, determine the third:
  - Force
  - Area
  - Pressure
- Given two of the following quantities in a fluid system, determine the third:
  - Pressure
  - Height of fluid
  - Weight density
- Given two or more voltage sources connected in series, determine the resultant voltage.
- Given a temperature in either degrees Celsius or degrees Fahrenheit, determine the equivalent temperature on the other scale.
- Describe how pressure in fluidal systems, voltage in electrical systems, and temperature difference in thermal systems are similar to force and torque in mechanical systems.
- Describe the conditions that must be met for equilibrium in each of the following energy systems:
  - Mechanical
  - Fluidal
  - Electrical
  - Thermal
- Successfully complete the laboratory activities entitled:
  - Gravity
  - Addition of Mechanical Forces
  - Addition of Torques
  - Stress and Strain
  - Density, Buoyancy, and Specific Gravity
  - Manometers
  - Electric Forces and Fields
  - Magnetic Forces and Fields
  - Thermometers
  - Temperature Difference and Heat Flow

II. Work

- Define work and energy in general terms that apply to any energy system, and distinguish work from energy in the following systems:
  - Mechanical translational
  - Mechanical rotational
  - Fluidal
  - Electrical

Thermal

- Define the following units of work and energy:
  - Foot-pound
  - Newton-meter
  - Joule
  - Calorie
  - British thermal unit
- Define the following terms and explain their usefulness in determining work done:
  - Radian (mechanical system)
  - Current (electrical system)
  - Specific heat (thermal system)
  - Heat capacity (thermal system)
- Given two of the following quantities in a mechanical translational system, determine the third:
  - Force
  - Displacement
  - Work
- Given two of the following quantities in a mechanical rotational system, determine the third:
  - Torque
  - Angular displacement
  - Work
- Given two of the following quantities in a fluidal system, determine the third:
  - Pressure difference
  - Volume displaced
  - Work
- Given two of the following quantities in an electrical system, determine the third:
  - Voltage
  - Charge transferred
  - Work
- Given the temperature difference across a uniform thickness of a substance, the dimensions of the substance, and its thermal conductivity, calculate the heat flow rate through the substance.
- Given two of the following quantities in a thermal system, determine the third:
  - Temperature change of object
  - Heat capacity of object
  - Work (heat energy transferred)
- Define and give examples of:
  - Latent heat
  - Sensible heat
- State the general equation for work, and explain how it applies to each of the following energy systems:
  - Mechanical translational
  - Mechanical rotational
  - Fluidal
  - Electrical
  - Thermal

- Successfully complete the laboratory activities entitled:
  - Work Done on an Elevator
  - Work Done by a Winch
  - Work Done by a Water Pump
  - Heat Energy Required for a Temperature Increase
  - Fundamentals of Air Conditioning

III. Rate

- Define the following rates and, where applicable, express their basic units both in SI and English systems of units:
  - Speed and velocity
  - Acceleration
  - Angular velocity
  - Angular acceleration
  - Volume flow rate
  - Mass flow rate
  - Electric current
  - Heat flow rate
- In a linear mechanical system, given all the quantities except one in each of the following groups, determine the unknown quantity:
  - Displacement, elapsed time, velocity
  - Initial velocity, final velocity, elapsed time, acceleration
  - Mass, force, acceleration
- In a rotational mechanical system, given all the quantities except one in each of the following groups, determine the unknown quantity:
  - Angular displacement, elapsed time, angular velocity
  - Initial angular velocity, final angular velocity, elapsed time, angular acceleration
- In a fluidal system, given all the quantities except one in each of the following groups, determine the unknown quantity:
  - Volume of fluid moved, elapsed time, volume flow rate
  - Mass of fluid moved, elasped time, mass flow rate
- Given two of the following quantities in an electrical system, determine the third:
  - Charge transferred
  - Elasped time
  - Current
- Given two of the following quantities in a thermal system, determine the third:
  - Heat energy transferred
  - Elapsed time
  - Heat flow rate
- State the general equation for rate, and explain how it applies to each of the following energy systems:
  - Mechanical translational
  - Mechanical rotational
  - Fluidal
  - Electrical
  - Thermal
- Successfully complete the laboratory activities entitled:
  - Velocity at Constant Acceleration
  - Displacement at a Constant Acceleration
  - Rotational Motion

Electric Current
Frequency
Heating and Cooling Rate

IV. Momentum

- Define the following terms; state the appropriate units in the mk/s system (SI) and the cg/s system; and give the equation for each:
  - Linear momentum
  - Angular momentum
  - Impulse
  - Angular impulse
  - Moment of inertia
- Given two of the following quantities, determine the third:
  - Mass of an object
  - Velocity of the object
  - Momentum of the object
- Given two of the following quantities, determine the third:
  - Moment of inertia of an object
  - Angular velocity of the object
  - Angular momentum of the object
- Given all the following quantities except one describing a linear collision, determine the unknown quantity:
  - Mass of first object
  - Initial velocity of first object
  - Final velocity of first object
  - Mass of second object
  - Initial velocity of second object
  - Final velocity of second object
- Explain the following concepts in a short paragraph each:
  - Conservation of linear momentum
  - Conservation of angular momentum
- Use a given equation to calculate the force produced on one blade of a reaction turbine, given the velocity of fluid and the mass of fluid per unit time striking the blade.
- Successfully complete the laboratory activities entitled:
  - Angular Momentum of a Flywheel
  - Impulse and Momentum
  - Gyroscope

V. Resistance

- Define resistance in a general way, and state the final form of the energy expended when a forcelike quantity does work to overcome resistance in any energy system.
- Calculate the magnitudes of starting and sliding frictional forces, given the mass or weight of the object, the coefficients of friction, and the angle of incline.
- Given two of the following quantities in fluidal, electrical, and thermal systems, determine the third:
  - Forcelike quantity
  - Rate
  - Resistance
- Describe the difference between laminar and turbulent flow.
- State the factors contributing to fluid resistance in pipes.
- State the factors contributing to electrical resistance in wires.

- State the factors contributing to the thermal resistance of objects.
- Describe with the use of graphs the definition of resistance as the ratio of forcelike quantity to rate in fluidal, electrical, and thermal systems. Include the units of forcelike quantity, rate, and resistance for each system.
- State the fundamental difference between sliding friction and resistance as it applies to fluidal, electrical, and thermal systems.
- Successfully complete the laboratory activities entitled:
  - Effects of Lubricants
  - Rolling Friction
  - Viscosity
  - Fluid Resistance in Pipes
  - Valves and Regulators
  - Ohm's Law
  - Series and Parallel Resistors
  - Conductors, Semiconductors, and Insulators
  - Resistance of Wires
  - Resistance of Semiconductor Junctions
  - Volt-Ohm-Milliammeter
  - Thermal Conductivity

RECOMMENDED TEXT

Unified Technical Concepts. Waco, TX: Center for Occupational Research and Development, 1980.

I. 1-0 Force
   1M1 Gravity
   1M2 Addition of Mechanical Forces
   1M3 Addition of Torques
   1M5 Stress and Strain
   1F2 Density, Buoyancy, and Specific Gravity
   1E3 Electric Forces and Fields
   1E4 Magnetic Forces and Fields
   1T1 Thermometers
   1T2 Temperature Difference and Heat Flow

II. 2-0 Work
   2M1 Work Done on an Elevator
   2M2 Work Done by a Winch
   2F1 Work Done by a Water Pump
   2T1 Heat Energy Required for a Temperature Increase
   2T4 Fundamentals of Air Conditioning

III. 3-0 Rate
   3M2 Velocity at Constant Acceleration
   3M3 Displacement at a Constant Acceleration
   3M5 Rotational Motion
   3E1 Electric Current
   3E2 Frequency
   3T1 Heating and Cooling Rate

IV. 4-0 Momentum
   4M1 Angular Momentum of a Flywheel

4M2 Impulse and Momentum
4M4 Gyroscopes

V. 5-0 Resistance
5M2 Effects of Lubricants
5M3 Rolling Friction
5F2 Viscosity
5F3 Fluid Resistance in Pipes
5F4 Valves and Regulators
5E1 Ohm's Law
5E2 Series and Parallel Resistors
5E4 Conductors, Semiconductors, and Insulators
5E5 Resistance of Wires
5E6 Resistance of Semiconductor Junctions
5E8 Volt-Ohm-Milliammeter
5T1 Thermal Conductivity

REFERENCES

Dierauf, Edward J., Jr., and Court, James E. Unified Concepts in Applied Physics. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1979.

PHYSICS II

DESCRIPTION

The second quarter of Physics builds on the foundation developed in the first quarter by presenting concepts of power, energy, force transformers, and energy convertors. The course balances theory related to these four concepts with practical hands-on experience in working with associated devices in the four energy systems (mechanical, fluidal, electrical, and thermal).

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
VI. Power	7.5	15
A. Power Equations		
1. Power defined		
2. Basic equation form		
B. Efficiency		
C. Mechanical Systems		
1. Translational		
2. Rotational		
D. Fluidal Systems		
E. Electrical Systems		
F. Thermal Systems		
VII. Potential and Kinetic Energy	7.5	15
A. Mechanical Systems		
1. Translational		
2. Rotational		
B. Fluidal Systems		
1. Volume/mass conversion		
2. Bernoulli's equation		
C. Electrical Systems		
1. Charge relationships		
2. Capacitors		
D. Thermal Systems		
VIII. Force Transformers	7.5	15
A. Principles of Force Transformers		
B. Mechanical Systems		
1. The pulley		
2. The lever		
3. The inclined plane		
4. The screw		
5. The wheel and the axle		
C. Fluidal Systems		
1. The hydraulic lift		
2. Mechanical advantage of a hydraulic lift		
D. Electrical Systems - Electrical Transformers		

	Student Contact Hours	
	Class	Laboratory
IX. Energy Convertors	8.5	17.5

A. General Considerations and Background
B. Convertors of Mechanical Input Energy
   1. Fluidal output energy
   2. Electrical output energy
C. Convertors of Fluidal Input Energy
   1. Mechanical output energy
   2. Electrical output energy
D. Convertors of Electrical Input Energy
   1. Mechanical output energy
   2. Thermal output energy
   3. Optical output energy
E. Convertors of Thermal Input Energy
   1. Mechanical output energy
   2. Fluidal output energy
   3. Electrical output energy
F. Convertors of Optical Input Energy
   1. Electrical output energy
   2. Thermal output energy

STUDENT LABORATORIES

VI. Power

Hydraulic Power - Student will determine experimentally the horsepower produced by a water pump sending fluid through a hydraulic system.

Electrical Power Measurement - A kilowatt-hour meter will be used to measure power consumed by various electrical devices, and student will gain experience in power calculations.

Efficiency of Electric Motors and Generators - A wattmeter and a prony brake are used to determine efficiency of an electric motor through experimental measurements and calculations.

Heat Exchangers - Pump, portable fan, wattmeter, and automobile radiator are employed in investigation of power exchange; students are exercised in power calculations as well.

VII. Potential and Kinetic Energy

Rotational Kinetic Energy of a Flywheel - Student will construct a simple flywheel from a wheel and axle and determine its energy-storage efficiency.

Venturi Meters - A triple-arm manometer is used in conjunction with a venturi meter to determine velocity of flow for a fluid; discussion of potential and kinetic energy changes in the pipe is included.

Pitot Tubes - A pitot tube is employed to investigate measurement of velocity of an automobile, with attention given to various features of construction of the pitot tube.

Gas Laws - A manometer is employed in investigation of Gay-Lussac's law and Boyle's law involving many measurements and calculations.

Energy Stored in a Capacitor - Student will experimentally obtain data from capacitor discharge curves to calculate energy-storage capability of the capacitor.

Energy Stored in an Inductor - An automobile ignition coil and an ammeter are employed in investigation of energy stored in a magnetic field.

Series and Parallel Capacitors - Effects of placing capacitors in series or parallel circuit arrangements are investigated by use of a voltmeter; methods for determination of unknown capacitance are included.

VIII. Force Transformers

Levers - Student will construct several levers and calculate the mechanical advantage of each from measurements taken.

Drive Systems - A phonograph turntable is employed in investigation of torque transformers, with examination of actions by gear systems, belt drives, and disk drives.

Gear Trains - Student will examine the gear drive of a metal-cutting lathe.

Hydraulic Press - Students will use disposable syringes, clear tubing, and slotted weights to construct and operate a simulated hydraulic press, with attention given to force transformation and mechanical advantage.

Electrical Transformers - Student will construct an electrical transformer, perform measurements of voltage and current, and investigate relationships between measured and calculated values.

IX. Energy Convertors

Turbines - Energy transformations are traced diagrammatically for gas, steam, wind, and water turbines while the student investigates these transformations in greater detail through experimentation with a water wheel and prony brake.

Fluid Pumps - Principles, characteristics, and applications of the hydrodynamic pump as well as several types of positive-displacement pumps are discussed, with direct lab experience with a hydrodynamic pump included.

Fans and Blowers - Air horsepower and efficiency of a fan motor are experimentally determined.

Vacuum Pumps - Student will examine two types of pumps used to produce a vacuum in an enclosed chamber experimentally, using vacuum gages to produce needed measurements.

Electric Generators - Basic theory and design of dc generators are examined while using electronic measurement instruments to determine electrical power generated by a generator.

Alternators - Student will use an oscilloscope and a VOM to determine output power and efficiency of an alternator.

Electric Motors - Student will construct a simple permanent-magnet motor and a series motor, then will operate and observe these motors.
Solenoids and Relays - Student will identify relay terminals and operate starter and electric motor control circuits.
Photovoltaic Materials - An optical power meter, milliammeter, and photovoltaic detector are employed to measure efficiency of conversion of light energy into electrical energy from a light source of a He-Ne laser.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

VI. Power
- Define "power" as it applies, in general, to all energy systems; and write equations that relate work, elapsed time, force, and rate to power in these energy systems:
  - Mechanical system
  - Fluidal system
  - Electrical system
- List for each energy system the SI and English units used to define power.
- Given any two of the following quantities in any energy system, determine the third:
  - Work (or forcelike quantity x displacementlike quantity)
  - Elapsed time
  - Power
- Given any two of the following quantities in any energy system, determine the third:
  - Forcelike quantity
  - Rate
  - Power
- Define the following terms:
  - Input power
  - Output power
  - Efficiency
- Given any two of the following quantities in any energy system, determine the third:
  - Input power
  - Output power
  - Efficiency
- Convert values for power expressed in any energy unit to equivalent values expressed in any other unit.
- Successfully complete the laboratory activities entitled:
  - Hydraulic Power
  - Electrical Power Measurement
  - Efficiency of Electric Motors and Generators
  - Heat Exchangers

VII. Potential and Kinetic Energy
- Define potential energy, kinetic energy, and conservation of energy by using examples from mechanical systems.

102

- Given any two of the quantities in the following groups, determine the third:
  - Mass, velocity, kinetic energy
  - Mass, height, potential energy.
  - Spring constant, spring displacement, potential energy
  - Moment of inertia, angular velocity, kinetic energy
  - Capacitance, voltage, potential energy
- Given Bernoulli's equation and the height of liquid in a tank, determine the exit velocity at the bottom of the tank if there is no fluid friction.
- List and decribe the three processes that transfer thermal energy.
- Discuss the conservation of energy as it applies to fluidal, electrical, and thermal systems.
- Successfully complete the laboratory activities entitled:
  - Rotational Kinetic Energy of a Flywheel
  - Venturi Meters
  - Pitot Tubes
  - Gas Laws
  - Energy Stored in a Capacitor
  - Energy Stored in an Inductor
  - Series and Parallel Capacitors

VIII. Force Transformers

- Describe specific force transformers in the mechanical translational, mechanical rotational, fluidal, and electrical systems; and discuss their fundamental similarity as transformers of forcelike quantities.
- Define the following terms:
  - Ideal mechanical advantage
  - Actual mechanical advantage
  - Efficiency
- Calculate the ideal mechanical advantage of a specific pulley, lever, screw, wheel and axle, hydraulic press or lift, and electrical transformer.
- Calculate the change in current in an ideal electrical transformer.
- Discuss how the role of resistance in a transformer dissipates energy input and reduces efficiency.
- Describe the power input and power output characteristics of a transformer that operates continuously.
- Successfully complete the laboratory activities entitled:
  - Levers
  - Drive Systems
  - Gear Trains
  - Hydraulic Press
  - Electrical Transformers

IX. Energy Convertors

- Describe energy convertors in general terms that apply to all energy-conversion devices.
- Describe the operation of the following energy convertors:
  - Vane pump
  - Electric generator
  - Turbine
  - Electric motor
  - Electric heater

Internal combustion engine
Boiler
Solar collector

- Given two of the following quantities, determine the third:
  Input energy
  Output energy
  Efficiency
- Given the efficiency of all the energy convertors used in an energy conversion system, determine the overall system efficiency.
- Successfully complete the laboratory activities entitled:
  Turbines
  Fluid Pumps
  Fans and Blowers
  Vacuum Pumps
  Electric Generators
  Alternators
  Electric Motors
  Solenoids and Relays
  Photovoltaic Materials

RECOMMENDED TEXT

Unified Technical Concepts. Waco, TX: Center for Occupational Research and Development, 1980.

VI. 6-0 Power
6F1 Hydraulic Power
6E1 Electrical Power
6E3 Efficiency of Electric Motors and Generators
6T1 Heat Exchangers

VII. 7-0 Potential and Kinetic Energy
7M3 Rotational Kinetic Energy of a Flywheel
7F2 Venturi Meters
7F3 Pitot Tubes
7F5 Gas Laws
7E2 Energy Stored in a Capacitor
7E3 Energy Stored in an Inductor
7E4 Series and Parallel Capacitors

VIII. 8-0 Force Transformers
8M1 Levers
8M3 Drive Systems
8M4 Gear Trains
8F1 Hydraulic Press
8E1 Electrical Transformers

IX. 9-0 Energy Convertors
9F1 Turbines
9F2 Fluid Pumps
9F4 Fans and Blowers
9F5 Vacuum Pumps
9E1 Electric Generators
9E2 Alternators

9E3 Electric Motors
9E4 Solenoids and Relays
9E5 Photovoltaic Materials

REFERENCES

Dierauf, Edward J., Jr., and Court, James E. Unified Concepts in Applied Physics. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1979.

PHYSICS III

DESCRIPTION

This third quarter of Physics will provide the student with practical knowledge of sound scientific principles behind devices and components addressed in four concepts: transducers, vibrations and waves, time constants, and radiation. Practical hands-on experience with devices common to many technologies is offered in the laboratory. Demands on student math ability should be satisfied by the equivalent experience of one year of algebra plus a basic knowledge of geometry and trigonometry.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
X. Transducers	8.5	17.5
A. Mechanical Transducers		
1. Microphone		
2. Piezoelectric pressure		
3. Strain gages		
4. Others		
B. Fluidal Transducers		
1. Turbine flowmeter		
2. Pressure-sensing		
C. Electrical Transducers, Meter Movement		
D. Thermal Transducers		
1. Thermocouple		
2. Others		
E. Optical Transducers		
1. Photoconductive photocell		
2. Photovoltaic cell		
XI. Vibrations and Waves	7.5	15
A. Types of Waves		
1. Transverse		
2. Longitudinal		
B. Wave Characteristics		
1. Wave velocity		
2. The wave equation		
3. Superposition		
4. Standing waves		
5. Interference		
C. Wave Motion as a Unifying Concept		
1. Mechanical systems		
2. Fluidal systems		
3. Electrical waves		
XII. Time Constants	7.5	15
A. Basic Considerations		
1. Thermal cooling		

	Student Contact Hours	
	Class	Laboratory
2. Radioactive decay		
B. Mechanical Systems		
1. Translational		
2. Rotational		
C. Fluidal Systems		
D. Electrical Systems		
E. Thermal Systems		
XIII. Radiation	7.5	15
A. Radiant Energy - Basics		
B. The Electromagnetic Spectrum		
1. Radio waves		
2. Television and radar		
3. Infrared		
4. Visible		
5. Ultraviolet		
6. X-rays		
7. Gamma		
C. The Nature of Electromagnetic Waves		
D. EM Radiation - Waves or Photons		
E. Characteristics of EM Radiation		
1. Reflection		
2. Refraction		
3. Polarization		
4. Propagation		
F. Particle Radiation		
1. Alpha rays		
2. Beta rays		

STUDENT LABORATORIES

X. Transducers

Strain Gages - Student will be exposed to measurement of strain by use of a strain gage, as well as measurement of resistance change in a conductor by application of a measured force.

Accelerometers - Student will use an accelerometer and an oscilloscope to measure a variety of accelerations, and will be introduced to the contribution of piezoelectric crystals.

Bourdon Tubes - This principal device for pressure measurement is examined as to its function and operation through calibration of a typical Bourdon tube.

Fluid-Flow Measuring Devices - Various devices used in the measure of fluid flow are examined, including an orifice plate and manometer system, turbine flowmeter, and magnetic flowmeter.

Vacuum Gages - Units of measure for pressure are discussed, along with practical experience in use of a mechanical valve to investigate operation of various vacuum gages.

Meter Movements - Student will employ a meter movement and use a commercial VOM to construct and investigate the circuit arrangements necessary to have a voltmeter and an ammeter.

Bimetallic Strips - Student will construct a bimetallic strip, measure its deflection with heat, and use a bimetallic strip to construct a control circuit.

Temperature Measuring Devices - Student will measure temperatures using a mercury thermometer, a VOM in conjunction with a thermocouple and a thermistor, and will examine other temperature measurement instruments.

Thermocouples - Student will investigate properties of a thermocouple while using a thermometer and a voltmeter to determine thermoelectric voltage of different thermocouples.

Thermistors - Resistance and temperature characteristics of a thermistor are investigated.

XI. Vibrations and Waves

Vibration Isolation - An accelerometer and an oscilloscope are employed in determination of vibration transmission from an electric motor and its support.

Resonance - Tuning forks, pendulums, and a resonance tube are used to experimentally investigate the phenomenon called resonance.

Alternating Voltage and Current - Student will use an oscilloscope, a signal generator, and a VOM to investigate resistance and reactance and to compare and contrast ac and dc characteristics.

Phase Relationships in AC Circuits - Impedance, phase angle, and power factor in RC, RL, and RLC circuits are investigated by use of an ammeter and a voltmeter.

Oscilloscope - This experiment provides hands-on experience in the operation of an oscilloscope.

Rectifiers - The action of turning alternating energy into single-direction energy is discussed for mechanical and fluidal systems, while electrical rectification is examined experimentally.

XII. Time Constants

Rate of Emptying Tanks - Fluidal system behavior will be investigated through the emptying of a large fluid container.

RLC Circuits - Student will use an oscilloscope, a VOM, and several circuit components to observe pulse shapes of overdamped, underdamped, and critically damped RLC circuits.

Response Time of Thermocouples - Student will measure response times for a conventional thermocouple and a thin-film thermocouple, and will use a thermocouple to measure thermal diffusivity of a sample of metal.

Time Constants of Heating and Cooling - Thermometers and insulated containers are used to determine the effect of surface characteristics of a hot body upon rates of cooling.

XIII. Radiation

Inverse Square Law - Spreading of Light - Irradiance as a function of distance from the source is investigated using an optical power meter.

The Optical Spectrum - Energy and frequency of photons will be calculated from measurements of wavelength through a grating spectroscope for various laboratory light sources.

Light Sources - A grating spectroscope and an optical power meter are used to observe the irradiance pattern and output spectra of incandescent and fluorescent light sources.

Lasers - Student will learn how to operate a low-power He-Ne laser and will observe the unique characteristics of coherent light.

Stroboscopes - Light Pulses - Student will use the stroboscope to accomplish measurement of rotational rate of a fan, observe water drop formation, and check the timing of an automobile engine.

Optical Filters - Absorption of Light - Transmission curves versus filter thickness and calculation of the absorption coefficient of optical filters are accomplished through use of a laser and a power meter.

Specular and Diffuse Reflection of Light - Characteristics of diffuse and specular reflections of light are compared by use of a laser and a power meter.

Image Formation with Mirrors - Real and virtual images are investigated by use of concave and convex mirrors, as is the construction of a solar furnace.

Prisms - Refraction and Dispersion of Light - Light velocity and the index of refraction of a prism at several wavelengths will be investigated by use of a prism spectrometer.

Lenses - Focusing and Spreading of Light - Student will construct a small refracting-type telescope and investigate the action of light passing through lenses.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

X. Transducers

- In a short paragraph, define a transducer. Include a distinction between those transducers that require external energy sources and those that do not.
- Describe the operation of the following transducers:
  - Strain gage
  - Accelerometer
  - Microphone
  - Turbine flowmeter
  - Barometer
  - Meter movement
  - Thermocouple
  - Thermistor
  - Bimetallic strip
  - Photoconductive cell
  - Photovoltaic cell

- Successfully complete the laboratory activities entitled:
  - Strain Gages
  - Accelerometers
  - Bourdon Tubes
  - Fluid-Flow Measuring Devices
  - Vacuum Gages
  - Meter Movements
  - Bimetallic Strips
  - Temperature Measuring Devices
  - Thermocouples
  - Thermistors

XI. Vibrations and Waves

- Distinguish between longitudinal and transverse waves by giving at least two examples of each type and by drawing and labeling a sketch of each.
- Define the following terms associated with waves and wave motion:
  - Propagating medium
  - Wavelength
  - Frequency
  - Period
  - Displacement
  - Amplitude
  - Phase
  - Standing wave
  - Constructive interference
  - Destructive interference
  - Beats
- Calculate the wavelength of a wave, given its velocity and frequency.
- Interpret the following equation, explaining the significance of each symbol:

  $y = A \sin 2\pi \left(\frac{x}{\lambda} - ft\right)$.

- Explain the meaning of the expression, "The current leads the voltage by a given phase angle" by using sine-wave sketches of both current and voltage.
- Describe the superposition principle.
- Describe wave phenomena in each of the following energy systems:
  - Mechanical
  - Fluidal
  - Electrical
- Successfully complete the laboratory activities entitled:
  - Vibration Isolation
  - Resonance
  - Alternating Voltage and Current
  - Phase Relationships in AC Circuits
  - Oscilloscope
  - Rectifiers

XII. Time Constants

- Define the following terms:
  - Steady state
  - Transient
  - Damping

Time constant
Half-life
Decay constant

- Draw and label a graph showing an exponentially-decaying function. Include on the graph the time constants $T_{1/2}$ and $T_{1/e} \equiv \tau$. Also, write an equation for the function shown on the graph.
- Given the initial temperature of a hot body, the ambient temperature of its surroundings, and the thermal time constant of the system, determine the temperature of the body after a specified time interval.
- Given the number of radioactive atoms in a sample and the decay constant, determine the number of atoms remaining after a specified time interval.
- Given the values of resistance, capacitance, and applied voltage in an RC electrical circuit, determine the time constant for the circuit, the time required for the capacitor voltage to reach 99% of the applied voltage, and the circuit current and capacitor voltage after a specified time interval.
- Explain how the concept of time constants can be applied to the following energy systems; give a specific example in each case:
  Mechanical translational
  Mechanical rotational
  Fluidal
  Electrical
  Thermal
  Optical
  Nuclear
- Successfully complete the laboratory activities entitled:
  Rate of Emptying Tanks
  RLC Circuits
  Response Time of Thermocouples
  Time Constants of Heating and Cooling

XIII. Radiation

- Describe in one or two sentences the basic properties of each of the following types of radiation:
  Sound
  Light
  Alpha and beta particles
- Define electromagnetic radiation (radiant energy), and describe a simple experiment that illustrates how electromagnetic radiation can be created.
- List the frequencies in the electromagnetic spectrum from long wavelength EM waves of ac power (60 hertz) to gamma rays (10^{22} hertz), including each major part - radio, FM, television, radar, microwave, infrared, visible, ultraviolet, X-ray, and gamma ray.
- Given the equation $v = \lambda f$ - relating wave speed, wavelength, and frequency - determine the radiation frequency for any part of the electromagnetic spectrum.
- Given the equation $E = hf$ or $E = h\,c/\lambda$, determine the energy of different waves in the EM spectrum.
- Describe qualitatively the nature of an electromagnetic wave in terms of electric and magnetic fields; state what is always required to

generate an EM wave; and explain how EM waves are propagated through empty space without benefit of an elastic medium.

- Describe a photon, and explain why both wave and particle-like (photon) phenomena are required to describe interaction of EM radiation with matter. Give examples in which the wave character is most useful in describing EM radiation and in which the photon character is most useful.
- Explain what is meant by the inverse square law and how this law is used to describe the fall-off of EM radiation propagating from a small source.
- Define polarization, and explain what is meant by polarized EM radiation - in particular, polarized light.
- Define visible radiation, and determine its limits numerically in terms of wavelength, frequency, and energy.
- Describe the reflection and refraction of EM radiation - especially light - and set up an experiment to verify the two laws.
- Differentiate between alpha and beta radiation and gamma radiation.
- Briefly explain each of the three parts in the symbol $_{92}U^{238}$.
- Given the appropriate equipment, illustrate and verify the inverse square law of EM radiation in the visible region.
- Given the appropriate equipment, produce and detect polarized light in the microwave region.
- Successfully complete the laboratory activities entitled:
  - Inverse Square Law - Spreading of Light
  - The Optical Spectrum
  - Light Sources
  - Lasers
  - Stroboscopes - Light Pulses
  - Optical Filters - Absorption of Light
  - Specular and Diffuse Reflection of Light
  - Image Formation with Mirrors
  - Prisms - Refraction and Dispersion of Light
  - Lenses - Focusing and Spreading of Light

RECOMMENDED TEXT

Unified Technical Concepts. Waco, TX: Center for Occupational Research and Development, 1980.

X. 10-0 Force Transformers
10M1 Strain Gages
10M2 Accelerometers
10F1 Bourdon Tubes
10F4 Fluid-Flow Measuring Devices
10F5 Vacuum Gages
10E1 Meter Movements
10T2 Bimetallic Strips
10T3 Temperature Measuring Devices
10T4 Thermocouples
10T5 Thermistors

XI. 11-0 Vibrations and Waves
11M3 Vibration Isolation

11M4 Resonance
11E1 Alternating Voltage and Current
11E2 Phase Relationships in AC Circuits
11E3 Oscilloscope
11E4 Rectifiers

XII. 12-0 Time Constants
12F1 Rate of Emptying Tanks
12E3 RLC Circuits
12T1 Response Time of Thermocouples
12T2 Time Constants of Heating and Cooling

XIII. 13-0 Radiation
13L1 Inverse Square Law - Spreading of Light
13L2 The Optical Spectrum
13L3 Light Sources
13L4 Lasers
13L5 Stroboscopes - Light Pulses
13L6 Optical Filters - Absorption of Light
13L7 Specular and Diffuse Reflection of Light
13L8 Image Formation with Mirrors
13L9 Prisms - Refraction and Dispersion of Light
13L10 Lenses - Focusing and Spreading of Light
13N3 Radioactivity

REFERENCES

Dierauf, Edward J., Jr., and Court, James E. Unified Concepts in Applied Physics. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1979.

TECHNICAL COMMUNICATIONS

COURSE DESCRIPTION

Technical Communications will provide the student with working knowledge of the use of communication techniques, procedures, and formats used in industry and business. The student will learn accepted methods of describing devices and processes, and of making oral and written technical presentations. Also, proper use of written manuals, guides, specifications, and vendor instructions will be reviewed.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Introducing Technical Communications	3	0
A. Purpose of Course		
B. Definition of Technical Writing		
C. Basic Principles of Technical Writing		
D. Style		
1. Audience		
2. Purpose		
3. Scientific attitude		
E. Introduction to Oral Communications		
II. Conducting Research	4	0
A. Completing Preliminary Steps		
B. Assembling Sources		
1. Searching subject heading indexes		
2. Using the card catalog		
3. Consulting specialized guides		
4. Locating bibliographies		
5. Using indexes and abstract services		
6. Using reference materials		
C. Using Research Results		
1. Taking notes		
2. Assembling an annotated bibliography		
III. Planning the Report	5	0
A. Outlines		
1. Outlining effectively		
2. Rules for formal outlines		
B. Abstracts and Introductory Summaries		
1. Types of abstracts		
2. Suggestions for writing abstracts		
IV. Writing Definitions	6	0
A. What Should be Defined		
1. Familiar words for unfamiliar things		
2. Unfamiliar words for familiar things		

	Student Contact Hours	
	Class	Laboratory
B. How Definitions are Constructed		
1. Informal		
2. Formal		
a. Class.		
b. Distinguishing characteristics		
c. Summary of formal usage		
d. Additional suggestions for formal usage		
3. Amplified definitions		
C. Where Definitions Should be Placed		
V. Describe Mechanisms	10	0
A. Describing Mechanisms		
B. Components of the Description of a Mechanism		
1. Some potential problems		
2. Specifications		
C. Describing Malfunctions of a Mechanism		
VI. Describing Processes	10	0
A. Describing a Process		
B. Problems Encountered in Describing a Process		
C. Instructions in a Process		
D. Describing Malfunctions of a Process		
VII. Putting Skills Into Practice: Writing a Formal Technical Report	10	0
A. Writing the Rough Draft		
1. Prefatory pages		
2. Body of the report		
3. Appendix		
B. Editing the Rough Draft		
C. Producing the Final Copy		
VIII. Presenting an Oral Technical Report	6	0
A. Oral and Visual Aspects of Technical Communications		
B. Oral Presentations and Activities		
1. Oral reports and presentations		
2. Leading conferences and group discussions		
C. Visual Illustrations		
1. What illustrations can do		
2. Types of illustrations		
D. Presenting the Oral Report		

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Explain the importance of technical communications to the engineering technician.

- Use appropriate reference materials in preparing a technical report.
- Write a formal and an informal outline for a technical report.
- Write an abstract for a technical report.
- Write appropriate definitions of technical terminology.
- Precisely describe the characteristics and components of mechanisms.
- Precisely describe the characteristics and components of processes.
- Prepare a formal technical report using accepted formats and style.
- Deliver a technical speech using supportive visual aids.

RECOMMENDED TEXT

Technical Communications. Waco, TX: Center for Occupational Research and Development, 1980.

TC-01 Introducing Technical Communications
TC-02 Conducting and Reporting Research
TC-03 Writing Outlines and Abstracts
TC-04 Writing Definitions
TC-05 Describing Mechanisms
TC-06 Describing a Process
TC-07 Performing Oral and Visual Presentations
TC-08 Preparing a Formal Report

TRIGONOMETRY

COURSE DESCRIPTION

This course is designed to develop trigonometric skills required for engineering technicians as applied to the solution of practical problems encountered in electrical, mechanical, thermal, hydraulic, pneumatic and optical technologies. Topics to be covered include trigonometric functions of angles, vectors, solutions to oblique triangles, graphs of trigonometric functions, j-Operator, identities, inverse functions and logarithms.

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Trigonometric Functions of Any Angle	3	
A. Signs of the Trigonometric Function		
B. Radian		
C. Applications of the Use of Radian Measure		
II. Trigonometric Functions	5	
A. Angles		
B. The Right Triangle		
C. The Trigonometric Functions		
D. Values of the Trigonometric Functions		
III. Vectors and Triangles	10	
A. Vectors		
B. Application of Vectors		
C. Oblique Triangles		
D. The Law of Sines		
E. The Law of Cosines		
IV. Graphs of the Trigonometric Functions	7	
A. Graphs of $Y = A \sin x$ and $Y = A \cos x$		
B. Graphs of $Y = A \sin bx$ and $Y = A \cos bx$		
C. Graphs of $Y = A \sin (bx + c)$ and $Y = A \cos (bx + c)$		
D. Graphs of $Y = \tan x$, $Y = \cot x$, $Y = \sec x$ $Y = \csc x$		
E. Application of the Trigonometric Graphs		
F. Composite Trigonometric Curves		
V. The j-Operator	10	
A. Imaginary and Complex Numbers		
B. Operations with Complex Numbers		
C. Graphical Representation of Complex		
D. Polar Form of a Complex Number		
E. Exponential Form of a Complex Number		
F. Products, Quotients, Powers, and Roots of Complex Numbers		

	Student Contact Hours	
	Class	Laboratory
VI. Properties of the Trigonometric Functions	5	
A. Fundamental Trigonometric Identities		
B. Sine and Cosine of the Sum and Difference of Two Angles		
C. Double-Angle Formulas		
D. Half-Angle Formulas		
E. Trigonometric Equations		
VII. The Inverse Trigonometric Functions	5	
A. Inverse Trigonometric Functions		
B. Principal Values		
VIII. Logarithms	7	
A. Exponential and Logarithmic Functions		
B. Graphs of $Y = b^X$ and $Y = \log_b x$		
C. Properties of Logarithms		
D. Logarithms to the Base 10		
E. Logarithms to the Base e		

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

I. Trigonometric Functions of Any Angle
- Define the six trigonometric functions.
- Determine the sign of the function of an angle.
- Find the value of a given function of an angle.
- Find the value of the angle of the inverse trigonometric function.
- Convert between systems of angular measurement.
- Make trigonometric computations with angles measured in radians.

II. Trigonometric Functions
- Define trigonometric functions using the standard right triangle.
- Solve right triangles.

III. Vectors and Triangles
- Define vector quantities and give examples.
- Graphically represent a vector.
- Graphically add and subtract vectors.
- Use vectors to solve problems by resolving vectors into rectangular components.
- Solve oblique triangles using the law of sines.
- Solve oblique triangles using the law of cosines.

IV. Graphs of the Trigonometric Functions
- Graph the trigonometric functions $Y = A \sin x$ and $Y = A \cos x$.
- Graph the trigonometric functions $Y = A \sin bx$ and $Y = A \cos bx$.
- Graph the trigonometric functions $Y = A \sin (bx + c)$ and $Y = A \cos (bx + c)$.
- Determine amplitude, period, and phase of periodic (sinusoidal) motion.
- Graph the trigonometric functions $Y = \tan x$, $Y = \cot x$, $Y = \sec x$, $Y = \csc x$.

- Describe various types of motion in terms of the sine curve.
- Graphically combine two or more trigonometric curves.

V. The j-Operator
- Define and describe the complex number system.
- Perform basic algebraic operations with complex numbers.
- Represent complex numbers graphically.
- Write complex numbers in polar form.
- Write complex numbers in exponential form.
- Calculate the product, quotient, powers, and roots of complex numbers.

VI. Properties of the Trigonometric Functions
- Recognize and verify the basic trigonometric identities.
- Prove the validity of trigonometric equations by means of the trigonometric identities.
- Compute the sine and cosine of the sum and differences of two angles.
- Compute the value of the sine and cosine of the double angle.
- Compute the value of the sine and cosine of the half angle.
- Solve trigonometric equations by use of the trigonometric identities.

VII. The Inverse Trigonometric Functions
- Recognize and define inverse trigonometric functions.
- Compute the principal value of a given trigonometric function.

VIII. Logarithms
- Recognize and define an equation in exponential form.
- Recognize and define an equation in logarithmic form.
- Graph exponential and logarithmic functions.
- Perform algebraic operations with logarithmic expressions using the properties of logarithms.
- Write a number as a logarithm to the Base 10.
- Write a number as a logarithm to the Base e.
- Solve exponential and logarithmic equations.

RECOMMENDED TEXT

Clar and Hart. Mathematics for the Technologies. Englewood Cliffs, NJ: Prentice-Hall.

Paul and Shaevel. Essentials of Technical Mathematics with Calculus. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Washington, Allyn J. Basic Technical Mathematics With Calculus. 3rd ed. Benjamin Cummings.

DEVELOPED UNDER CONTRACTUAL AGREEMENT WITH

DIVISION OF PROGRAM DEVELOPMENT
OFFICE OF VOCATIONAL EDUCATION
GEORGIA DEPARTMENT OF EDUCATION
ATLANTA, GEORGIA 30334
CHARLES McDANIEL, STATE SUPERINTENDENT OF SCHOOLS
1982

Federal law prohibits discrimination on the basis of race, color or national origin (Title VI of the Civil Rights Act of 1964); sex (Title IX of The Educational Amendments of 1972 and Title II of the Vocational Education Amendments of 1976); or handicap (Section 504 of the Rehabilitation Act of 1973) in educational programs or activities receiving federal financial assistance.

Employers, students and the general public are hereby notified that the Georgia Department of Education does not discriminate in any educational programs or activities or in employment policies.

The following individuals have been designated as the employees responsible for coordinating the department's effort to implement this nondiscriminatory policy:

Title II - Loydia Webber, Vocational Equity Coordinator
Title VI - Peyton Williams, Jr., Associate Superintendent of State Schools and Special Services
Title IX - Evelyn Rowe and Myra Tolbert, Coordinators
Section 504 - Jane Lee, Coordinator of Special Education

Inquiries concerning the application of Title II, Title VI, Title IX or Section 504 to the policies and practices of the department may be addressed to the persons listed above at the Georgia Department of Education, State Office Building, Atlanta 30334; to the Regional Office for Civil Rights, Atlanta 30323; or to the Director, Office of Civil Rights, Education Department, Washington, DC 20201.